UROLOGY

VOLUME I

UROLOGY

THE DISEASES OF THE URINARY TRACT IN MEN AND WOMEN

A BOOK FOR PRACTITIONERS AND STUDENTS

BY

RAMON GUITERAS, M.D. (HARV.)

PROFESSOR OF GENITO-URINARY SURGERY, NEW YORK POST-GRADUATE MEDICAL SCHOOL; VISITING SURGEON TO THE COLUMBUS AND POST-GRADUATE HOSPITALS; CONSULTING SURGEON TO THE CITY AND FRENCH HOSPITALS; FORMERLY PROFESSOR OF ANATOMY, OPERATIVE SURGERY AND GYNECOLOGY, POST-GRADUATE MEDICAL SCHOOL, AND VISITING SURGEON IN THE DEPARTMENT OF GENITO-URINARY DISEASES AND GYNECOLOGY, NEW YORK CITY HOSPITAL; MEMBER OF THE AMERICAN MEDICAL ASSOCIATION, THE AMERICAN UROLOGICAL ASSOCIATION, THE FRENCH UROLOGICAL ASSOCIATION, THE AMERICAN PUBLIC HEALTH ASSOCIATION, THE AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS, THE AMERICAN ASSOCIATION OF OBSTETRICIANS AND GYNECOLOGISTS, THE ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES, THE AMERICAN SOCIETY OF TROPICAL MEDICINE, THE NEW YORK ACADEMY OF MEDICINE, AND THE HARVARD MEDICAL SOCIETY

WITH NINE HUNDRED AND FORTY-THREE ILLUSTRATIONS IN TEXT AND SEVEN PLATES

VOLUME I

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TO MY TEACHERS

HENRY J. BIGELOW
THEODOR BILLROTH
ERNEST FINGER
FELIX GUYON
JAMES E. KELLY
PRINCE A. MORROW
FESSENDEN N. OTIS
FREDERICK R. STURGIS
ROBERT W. TAYLOR
ROBERT ULTZMANN
LEOPOLD VON DITTEL
ERNEST VON BERGMANN

THIS WORK IS DEDICATED
AS A TOKEN OF RESPECT, ESTEEM
AND GRATITUDE

PREFACE

This work on Urology includes all the diseases of the urinary tract, both medical and surgical, in men and women. The upper part of the urinary tract, the kidneys and ureters, is practically the same in both sexes. The middle part, the bladder, is also the same, although its relations are different, and, whereas bladder troubles in men are principally due to intravesical causes and obstructions in the prostate and urethra, the troubles in women are generally due to extravesical causes in the pelvis. It is obvious, therefore, that it is the lower third of the urinary tract, the urethra, which principally differs in men and women.

In men it has been thought advisable to consider the diseases of the genital tract together with the urinary, as the genital tract empties into the prostatic urethra and from this point to the external urinary meatus the two tracts are in common. In women, on the other hand, the urinary and genital tracts are separated from each other throughout their entire extent, meeting externally at the urogenital sinus in the vestibule. The internal genital organs are, however, in close enough contact with the bladder to give rise to many disagreeable urinary symptoms, most of which have been carefully considered. If an attempt were made to consider the genital tract of the female as thoroughly as that of the male, it would necessarily embrace gynecology, which is not within the scope of this work.

It has been my aim in writing the text to consider principally cause, diagnosis and treatment and not to go as deeply into pathology as many writers do. The illustrations were chosen to show certain pathological conditions and to illustrate the steps of operations, and, excepting the purely anatomical and pathological drawings of specimens, they are principally diagrammatic and schematic.

The first part of the book is preparatory to the second. It contains the anatomy of the urinary organs in the male and female and the laboratory methods of examining the urine, discharges and blood. The different varieties of offices for this kind of work are then considered with their equipment, the instruments and apparatus recommended and the methods of sterilization of the apparatus and instruments. The technique employed in using the apparatus and the general instruments that compose the armamentarium of the urinary surgeon as well as the special instruments, such as the urethroscope and cysto-

scope, is carefully described. A lengthy description of the general and special urinary symptoms and disturbances of urination are then entered into, and urinary fever is thoroughly discussed.

The history and examination of the patient, showing the manner of arriving at a diagnosis, are then taken up. This is followed by a chapter on urological therapeutics in which drugs, exercise, diet and the use of water, internally and externally, as well as by rectum, intravenous injections and hypodermoclysis, are fully considered. Asepsis and antisepsis and general and local anesthesia, such as are used in the various urological operations, are also carefully described. A small section on the diseases of metabolism is here brought in and is a valuable addition to the work.

The second part of the work is principally clinical and operative, and the diseases of the various organs of the urinary tract, the kidneys, ureters, bladder, prostate, urethra and the genital organs in the male have been taken up *seriatim*; and finally a chapter on lues was added. The most modern methods of examination of the patient and diagnosis are here described in great detail. The medical and palliative treatment of diseases have, however, been gone into as carefully as the surgical, and the details of such treatment are thoroughly explained. Lengthy historical data have been omitted and statistics have not been recorded and quoted fully. As the object of the book has been to make it a comprehensive work for the practitioner, the bibliography has not been given great prominence.

Most of the teachings in the book are the same as I have advocated in my lectures during the last twelve years. They are my own views on the subject, some original and others taken from the teachings and writings of others that appeal to me as sound and worthy of recommendation.

Having taught in the New York Post-Graduate Medical School and Hospital for over twenty years, I believe I understand the requirements of the general practitioner, and therefore, after repeated requests from many students, I have endeavored to present the subject in a way which I believe will be satisfactory to them.

I wish to thank Dr. H. T. Brooks, Dr. Faxton Gardner, Mr. K. K. Bosse, Dr. David Geiringer and Dr. F. Robbins for their assistance in the text, and Dr. David Geiringer for the illustrations he has made.

For the remaining illustrations I wish to thank the various authors whose names appear on the legends. If in any case I have not given credit where it is due, it is on account of being doubtful whose name to inscribe. I wish particularly to thank Drs. Ashton, Corner, Deaver, Kelly, Lewis, Lydston, Luys, Manson, Wallace, Watson and Cunningham and White and Martin for the kind permission to use their illustrations.

RAMON GUITERAS,

80 MADISON AVENUE, NEW YORK CITY.

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UROLOGY

VOLUME I

CHAPTER I

HISTORY OF DISEASES OF THE URINARY TRACT

Ancient Urology.—Diseases of the urinary tract have been known and treated, both in a medical and surgical way, for many centuries. Medical treatment was first recorded in the Papyrus of Ebers, written 1550 years B.C., in which were given many prescriptions for their cure. From this time until the present, various remedies have been used internally and externally by medical men, and by the monks during the Middle Ages, when the practice of medicine was principally in their hands.

The history of the progress of surgery has been interesting, although nothing was written upon it until the time of the "Ayurveda of Sucrutu," the great work of the Hindoos in India, which was brought out about one thousand years after the first recorded manuscript. The first operation spoken of in this later work was perineal lithotomy, which was then performed in practically the same way as it is to-day. The Hindoos at this time were also treating strictures by gradual dilation with sounds of metal or wood, and were treating diseases of the urethra and bladder by injections.

Hippocrates (about 400 B.C.) was the next great writer. Among other subjects, he was interested in vesical calculi, and described accurately how a stone grows gradually from a nucleus. He thought that lithotomy should be performed only by a lithotomist. He was the first to be interested in the surgery of the kidney, and taught that, as soon as a swelling appeared in that region, it should be cut down upon. He also wrote on the subject of urethral abscess and cystitis, and was the first to point out the change in the urine in diseases of the kidney and bladder.

Cornelius Celsus, the great Roman medical writer who lived at the beginning of the Christian era, was the next to write extensively on urinary diseases. He wrote on urethrotomy for impacted urethral stone; catheterization for retention of urine, especially in old men; vesical calculus and lithotomy, including after-treatment; and the care of wounds and fistulæ. Perineal urethrotomy was also performed for stricture by the Roman surgeons one hundred and fifty years later.

Galen was the next writer of consequence. He wrote upon incontinence and retention of urine, and described an "S-shaped" or curved catheter which he used for the relief of the latter trouble.

Cælius Aurelianus, at the beginning of the fourth century, was the next to interest himself in diseases of the bladder. He used a stone-searcher for the diagnosis of vesical calculus.

Mediæval Urology.—We thus see that, in the beginning of the Middle Ages, diseases of the urinary tract had been treated medically for two thousand years, while surgical interference had been going on for a thousand years. Diseases of the urethra, prostate, bladder and kidney were already known, and many of them had been operated upon. It was strange therefore that at such a time a decadence should have taken place, that the practice of medicine should have fallen into the hands of the monks, and that surgery was attended to by the barber and charlatan. This condition existed until the fourteenth century, when scientific surgery again started up in Paris, at the College of Saint Come, founded by Jean Pitard, and thence slowly extended over Europe. The advances along the urological line were evidenced by the discovery of movable kidney in 1497 by Mesure of Venice; the improvement in the technique of stricture operations by Ambrose Paré and Richard Wiseman; the works of Gitter of Leipsic on wounds of the kidney; the rescue of lithotomy from the hands of the layman and the variation of its technique by Pierre Franco.

Changes of the urine had been spoken of since the time of Hippocrates, but the first work of any scientific importance was that of Protospathori in the seventh century; for he not only described normal urine, but also, in a clear way, the various changes that took place in the urine of disease. Actuarius, a Turk, wrote the first extensive work on this subject in the twelfth century, and it remained an authoritative treatise for five hundred years.

During the heyday of the Salernian School, near Naples, all the physicians were practically urologists, as they depended largely upon the urine for diagnosis and prognosis, and the urinal became the insignia of the physician and the emblem of medicine. At this time, the examination of the urine was resorted to, not only by the regular practitioner and the university graduate, but also by the school of quacks, known as uromancers or uroscopists, who gravely inspected urine passed into a glass flask, guessed the illness and temperament of the patient, and dispensed miraculous cures.

Paracelsus and Van Helmont, in the latter part of the sixteenth century, introduced the spagiric or so-called analytic methods of the diagnosis of disease, which depended on the proportion in which the three elements of man's nature—mercury, sulphur, and salt—occurred in the urine. Boerhaeve and Bellini, in the seventeenth century, added to the study of urine. Boerhaeve distilled the urine and weighed the vapors. When the vapor occupied a certain part of the still, it pointed to disease in a certain part of the body. He was

the first to discover the specific gravity of urine. Bellini advocated the study of the average urine of the healthy individual, the amount passed and the specific gravity as a standard with which the unhealthy urine should be compared.

In the latter part of the eighteenth century, there was a decided advance in urinary analysis. Cotugno discovered albumin in the urine of diseased kidneys by boiling it. Roulle and Cadet discovered urea and isolated many salts of the urine, and Schule discovered uric acid.

It will thus be seen that, at the dawn of the nineteenth century, a good working basis existed in the study of urinary diseases, especially in the line of urinary examinations and the treatment of urethral and bladder diseases.

Modern Urology.—Modern urological history may be divided into two periods, the first and second halves of the nineteenth century, the first of which was preparatory to the second.

During the first half of the century the work was principally confined to improving and elaborating urethral and bladder work, urinary examination, and the study of pathology.

In 1805, Bozzini of Frankfort, invented an apparatus for illuminating the urethra and bladder, which was the first of a series of crude attempts that led to our present knowledge of urethroscopy and cystoscopy. In urethral work, Desormeaux in 1853 improved the endoscope. Later a cooling apparatus was added, which finally was supplanted by the mignon or cold lamp introduced by Preston, an electrician of Rochester, N. Y., at about the dawn of the twentieth century, thus giving us the practical instrument of to-day.

Maisonneuve in 1853 invented the first of the modern urethrotomes, which is still used in internal urethrotomy to cut through small strictures from the front backward, and in 1872, Otis invented his dilating urethrotome for cutting strictures of large size from behind forward. Both of these, although there have been many modifications, exist to the present day. The dilation of urethral strictures by the dilators of Oberländer and Kollmann have since then superseded the use of sounds with many practitioners. The method of treating urethritis by the irrigation of Janet, and numerous new remedies for hand injections, have entered into our urethral therapeutics.

In bladder work, the efforts to improve the diagnosis of pathological conditions by vision, led to the gradual development of the illuminating instruments, the first marked improvement being that of Brück, a dentist, who called his instrument a diaphanoscope. Improvements were slow and unimportant until 1876, when Nitze, Brenner and Leiter perfected their cystoscopes, giving us our present knowledge of cystoscopic diagnosis. These were rendered more practical three years later (1879) by introduction into them of the incandescent lamp, which enabled the urologist to employ it instead of the hot and less luminous platinum wire hitherto used, with a cooling apparatus.

Further improvement, due to the use of smaller and colder lamps, rendered the use of cooling devices—irrigation with water while examining—unnecessary.

In bladder surgery, Civiale (1817) performed the first successful lithotrity, the crushing of a vesical calculus, with an instrument which served as a prototype for the modern lithotrite. His lithotrite was modified by Weiss, Hodgson, Ferguson and Sir Henry Thompson, and finally by Bigelow (1877) who combined the operation with evacuation of the fragments of stone by means of an aspirator in one operation, litholapaxy. His evacuator for emptying the bladder of the last fragment of stone consisted of a very large hollow sound, with a large eye in its concavity, connected with a rubber bulb, between which and the sound was a bottle into which the fragments fell when sucked out by squeezing and releasing the bulb. While suprapubic lithotomy in this country has largely superseded Bigelow's operation, his method stands to this day in all parts of the world as the procedure best employed for the removal of stone in the bladder in a selected class of cases.

In the work on the kidney, that of Richard Bright (1827) was the foundation of our present knowledge of the medical diseases. Bright's investigations showed that many patients with dropsy and albumin in the urine had diseased kidneys, and although Catugno, the discoverer of albumin, had made it known a century before and Allison in 1823 had reported the occurrence of dropsy with albuminuria in kidney disease, Bright found the profession more receptive to scientific advances than did Catugno, and through his writings received such recognition that the name of Bright's disease was applied to pathological conditions of the kidney accompanied by albuminuria. In 1823, Scudmore of London had found that the urine of patients with albuminuria contained less urea than that of normal persons. The discovery of urinary casts by Viglia, some ten years after Bright's publication, added another important link to the chain of our present knowledge of urinary findings in nephritis. From these early studies sprang the elaborate researches of later years, as recorded in the text-books of Johnson ("Diseases of the Kidneys," London, 1852), Johann Fogel (1856), Rosenstein (1863), Senator (1896) and others.

In renal surgery, Paeslee performed the first nephrectomy (1868) by accident, in a case the diagnosis of which had been an ovarian tumor. Simon, the following year, removed the first kidney purposely in a case of calculous pyonephrosis, and took advantage of this step to write his important monograph on the kidney, in which he gave a definite classification of the surgical affections of the organ, thus stamping them formally for the first time as surgical.

Catheterization of the ureters, which now is one of the most important urological procedures, owes its birth to the efforts of Pawlik and Bozeman, who were the first to catheterize the ureters in women. The development of

this important procedure was, however, due to the cystoscopists. They added a compartment to their cystoscopes for the passage of a small woven catheter, then, by looking at the mouth of the ureter, they could push the catheter into the bladder until its end entered the ureter. The first catheterizing cystoscopic instrument was that of Brenner (1892), then followed those of Nitze (1895), Casper (1895), Albarran (1897), etc. Later they added to their instruments a double catheterizing apparatus which enabled them to catheterize both ureters at the same time.

One of the most important discoveries in urology, as in all other diseases, was the rôle of the microörganism as the causative agent of fermentation, decomposition and disease, by Louis Pasteur, described in a work called "La Generation Spontanée," which appeared in 1859. He took up in particular the Micrococcus ureæ, which causes urinary decomposition by splitting up urea into ammonia and other by-products, and suggested that the bacteria enter the bladder with dust particles that adhere to unclean instruments.

In 1879, Neisser announced the discovery of the gonococcus, a microörganism which has since then been found as the constant cause of blennorrhagic infection. Then followed rapidly the discoveries of the several important specific germs: The tubercle bacillus by Robert Koch, in 1882; the staphylococcus, the chief germ of suppuration, by Rosenbach, in 1884; and the colon bacillus—so often found in cystitis, pyelitis, etc.—by Escherich, in 1885. These discoveries changed many of our previous etiologic concepts and created entirely new therapeutic view points—antisepsis and asepsis. The development of a plate-culture method by Koch had a great deal to do with the later and more accurate studies on the bacteriology of cystitis, pyelitis, etc.

The *amalgamation of the diseases of the urinary tract* into the modern specialty has taken place through the combination of the work of numerous internists, surgeons, pathologists and bacteriologists at different times and in different ways.

A knowledge of diseases of the urethra and bladder and their treatment has existed since the earliest writings, and of diseases of the kidney since the days of Hippocrates. The diseases of the kidney, however, were not considered in common with those of the bladder and the urethra, but were rather in the hands of internists and general surgeons.

Bright was the first thoroughly to consider diseases of the kidney from the point of view of an internist, and Rayer and Simon as surgeons; while Civiale, Thompson, Mercier, Guyon, Maisonneuve, Ricord, and others were working on the bladder and urethra in both a medical and surgical way.

The laboratory men were principally engaged in the work of urinary analysis until Pasteur's discovery of bacteria and microbic infection, followed later by the discovery of the gonococcus, the tubercle bacillus and streptococcus, colon bacillus and others of the important forms of infection.

Cystoscopy in the hands of Nitze and Brenner was perhaps the final step of an amalgamation; for it allowed the surgeon who had examined and passed through the urethra to see with certainty the condition of the bladder wall, and to diagnosticate in many cases between bladder and kidney hematuria and pyuria, and in case of renal origin to see from which side the pathological urine had come.

The further investigations of the microbic causes of disease showed that the same germs that give rise to infectious bladder diseases were also the cause of suppurative renal disease: also that practically the same diseases existed in both organs; that is, tumors, tuberculosis, stone and suppurative inflammations. Furthermore, it was then learned that in cases of disease of the urethra, prostate and bladder, the infection may pass to the kidney directly up the ureters, or by the blood current or the lymphatic channels.

The catheterizing cystoscopes then came as another step in the relation between the two kidneys. In urinary cases, the analysis could tell us of disease of the bladder, or kidney, or both. The cystoscope could show us, in a bladder case, the degree of disease in this organ; while in a kidney case, the urine, withdrawn by the ureteral catheters, could tell us which of the kidneys excreted the urine that gave the pathological appearances to the general specimen. By this means, direct connection between the bladder and the kidney was established, and the study of the urinary tract from the bladder up was considered just as important, if not more so, than from the bladder down. Consequently, the direct reason for including the entire urinary tract from the capsule of the kidney to the external urinary meatus in both sexes can be better understood.

Having considered some of the principal direct steps taken in modern urology toward its advancement and development into the present specialty, we must consider a few important factors in general and special surgery that have an important bearing on the subject.

The acceptance of the fact that germs are the cause of surgical infections led to the consideration of the best way to be rid of them in surgical work; that is, the study of antisepsis and asepsis.

In 1859, Lemaire found that carbolic acid was the active constituent of coal tar and advocated it as the best antiseptic. It was thought that fermentation and putrefaction were due to the access to the wounds of particles from the air that could be destroyed by boiling, heat and chemical agencies. Among the latter the best agents were carbolic acid and bichlorid of mercury, in which wounds could be washed and dressings soaked.

The title "antiseptic method" was given by Lister to a form of wound treatment founded on certain definite principles and commenced by him in 1865. His studies were founded on the results of Pasteur's researches on spontaneous generation, which served as a guide in systematizing his investiga-

tion. Working on the hypothesis that the particles of dust-borne germs entered the wounds at the time of operation, he devised the carbolic spray as a means of rendering antiseptic the operative field in surgical operations. Asepsis then succeeded antisepsis, as it became apparent that it is better to exclude germs by having everything connected with the operation sterile, than to have germs present at the time of operation and then try to render them inert by the use of strong solutions. The sterilization of instruments, dressings, gowns, etc., beforehand, and the wearing of rubber gloves, proved more simple and effective than the more cumbersome methods of trying to sterilize after the operation had begun. For the technique of asepsis we are much indebted to another English surgeon, Lawson Tait.

Anesthesia was another great discovery for urinary surgery. In the years 1844–47, the three chief methods were discovered in rapid succession and at once began to exert an important influence upon the development of painless major urological operations. The discovery of nitrous oxid gas as an anesthetic by Wells gave us an invaluable aid for brief operations and for examinations that require perfect relaxation. The discovery of ether anesthesia by Morton in 1846, and of chloroform anesthesia by Simpson in 1847, gave us the most useful means of rendering patients unconscious that have yet been discovered. Ethyl chlorid and cocain, as brought out by Koler, are of great value as local anesthetics, and the great majority of urological operations can be performed under the influence of the latter.

In 1895, Conrad Roentgen discovered the X-ray, the perfection of which has brought to the urologist another valuable means of diagnosis in suspected cases of stone in the kidney, the ureter and bladder.

Laboratory experiments through the inoculation of small animals, have also been of great service to us in determining the presence or absence of tuberculosis in disease of the kidneys.

A few years ago, the determination of the relative efficiency of both kidneys, and especially of each kidney separately by various methods, was considered as one of the important diagnostic and prognostic criteria by surgeons and urologists in the study of renal diseases. The first of these methods employed to test the functional capacity of the kidney was cryoscopy, which consisted of freezing the urine. This was introduced in 1897 by Koranyo of Budapest, but has been little used in this country. The methylene blue test, popular with the French School, came next, the function of the kidney depending upon the early or late appearance in the urine of the blue or chromogen color after its injection into the body. The phloridzin test was advocated by Casper and Richter in 1900 and was the favorite method of the German School, but required more care on account of the frequent necessity of testing the urine for sugar.

It is difficult at the present time to see along what lines the progress in

urology will extend. The steps in diagnosis at present seem to be quite complete, and I think that progress will probably be along the lines of improved technique. At present, what is most needed is better coöperation between the patient and the surgeon in the study of the cases, and the continuation of medical treatment and careful observation before resorting to operation, except in urgent cases.

CHAPTER II

THE ANATOMY OF THE URINARY AND GENITO-URINARY TRACT

The urinary tract in both sexes is arranged in a series which begins at the kidneys and ends at the external urinary meatus. The various parts are the kidney, ureter, bladder and urethra. The kidneys and ureters are the same in both sexes, while the bladder is practically the same, differing only in regard to its external relations. It will thus be seen that the urethra is the part which differs the most in the two sexes. In women it is short and entirely independent of the genital tract in its functions and in its relations until it reaches the external meatus in the sinus uro-genitalis. In men, from the opening of the common ejaculatory ducts to the external meatus, the genital and urinary canals form a single passage. In both the male and the female the urinary organs meet the genital organs at the sinus uro-genitalis, which is found in the prostatic portion of the urethra in men and in the vestibule in women. At this point in the male the urinary tract communicates with the ejaculatory duct, the vesiculæ seminales, the vasa deferentia and the testes; while in the female it communicates at the sinus with the clitoris, the vulva, the vagina, the uterus, tubes and ovaries. In men the combined relations and functions of the urinary and genital tracts in the urethra, where they are in common, has given rise to the expression *genito-urinary tract* in their combined consideration.

In women, on the other hand, except in fœtal life, the genito-urinary organs are divided into two distinct tracts, the genital and the urinary. These are separated from each other throughout their entire course, and although they are in close contact with each other, they are never in common in a normal condition; for which reason they are not spoken of as the genito-urinary tract.

In the female the genital and urinary organs bear a definite relation to each other, the urinary being in front of the genital except where the ureter passes behind the broad ligament.

In the male, the urinary tract is also placed anteriorly as far as the urethra, but from the internal to the external meatus the urinary tract is surrounded by parts of the genital tract—namely, the prostate, the corpus spongiosum, and corpora cavernosa—the urethra being the common canal for the discharges from each.

The following illustrations will give an idea of the relation of the genital and urinary tracts to each other when removed from the body:

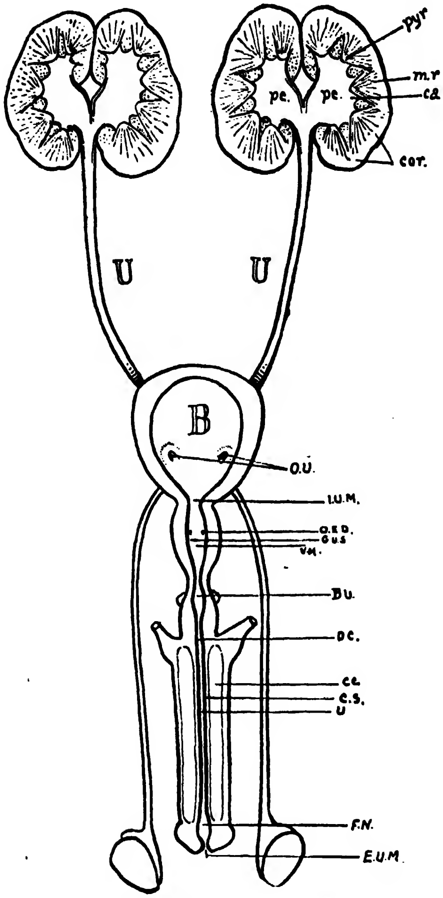


FIG. 1.—ANTERIOR VIEW OF THE OPENED GENITO-URINARY TRACT IN THE MALE.

pe, the pelvis of the kidney.
cor, the cortex, the part between the cortex and the pelvis being the medullary portion.
pyr, pyramid.
ca, the calices.
m.r, the medullary rays.
U, the ureters.
B, the bladder.
o.u, the ureteral openings.
i.u.m, the internal urinary meatus.
o.e.d, the openings of the ejaculatory ducts in the prostatic urethra.
g.u.s, the genito-urinary sinus.
v.m, the veru montanum.
b.u, the bulbous urethra.
d.c, openings of the ducts of Cowper's glands.
c.c, corpus cavernosum.
c.s, corpus spongiosum.
u, urethra.
f, fossa navicularis.
e.u.m, external urinary meatus.

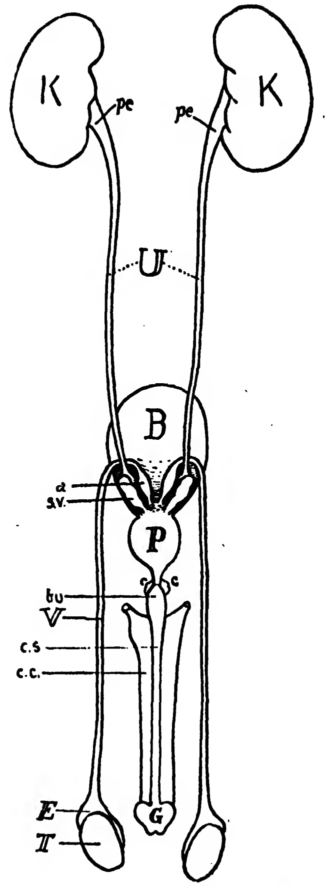
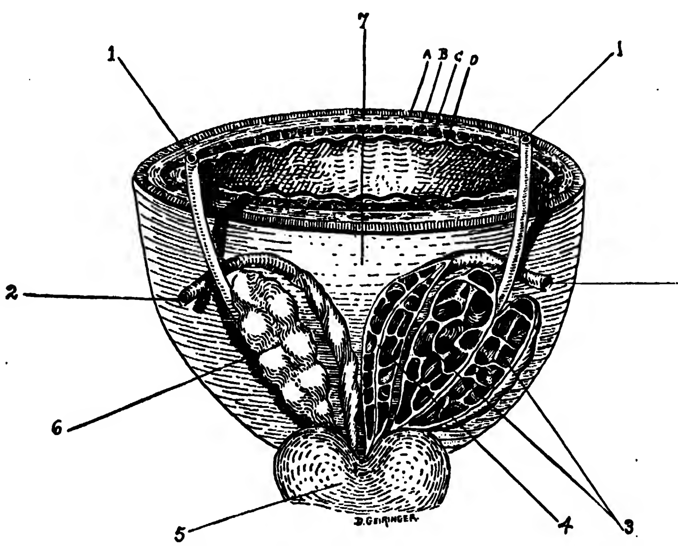


FIG. 2.—POSTERIOR VIEW OF THE GENITO-URINARY TRACT IN THE MALE.

K, kidney.
pe, pelvis.
U, ureters.
B, bladder.
V, vas deferens.
a, ampulla.
s.v, seminal vesicles.
P, prostate.
c, Cowper's glands.
T, testicles.
E, epididymis.
b.u, bulb of urethra.
c.s, corpus spongiosum.
c.c, corpus cavernosum.
G, glans penis.

Fig. 1 gives the anterior view of the genito-urinary tract in the male, and Fig. 2 the posterior. In Fig. 1 it can be seen how the urine excreted into the tubules of the kidney is carried down through the calices, the renal pelvis and the ureter into a reservoir, the bladder, where it accumulates and from which point it enters the urethra through which it is discharged from the body. In examining the first part of the urethra as it passes through the prostatic gland, we see the openings of the ejaculatory ducts that bring the secretions of the testes and seminal vessels into the urethra; also the openings of the prostatic ducts that discharge the prostatic fluid; while lower down the bulbous portion will be seen the mouth of the ducts of Cowper's glands, that are the last to contribute to the formation of the combined fluid known as semen at the time of its ejaculation.

In Fig. 2 it can be seen how the spermatozoa formed in the testes are carried up through the epididymis and vas deferens to the seminal vesicles where they are stored and from which point, mixed with the secretion of the vesicles, prostate and Cowper's glands, they are discharged from the urethra, as has already been shown in Fig. 1.



G. 3.—POSTERIOR VIEW OF THE RELATIONS OF THE GENITAL AND UR: ORGANS IN THE MALE.

1, ureters.
2, vasa deferentia.
3, right seminal vesicle laid open.
4, right vas deferens laid open.
5, prostate.
6, left seminal vesicle.
7, bladder.
A, outer muscular layer of bladder.
B, middle muscular layer of bladder.
C, inner muscular layer of bladder.
D, mucous membrane of bladder.

Fig. 3 is a view of the posterior aspect of the bladder prostate, seminal vesicles, ureters and vasa deferentia. The right vesicle and vas have been laid open.

Fig. 4 represents an interior view of the genito-urinary tract in the female; the kidney and ureter on right side are split, and the bladder and urethra below.

Fig. 5 represents a posterior view. The tubes, uterus and vagina are split. Here the genital tract is seen to be behind the urinary, excepting where the ureters pass behind the adnexa.

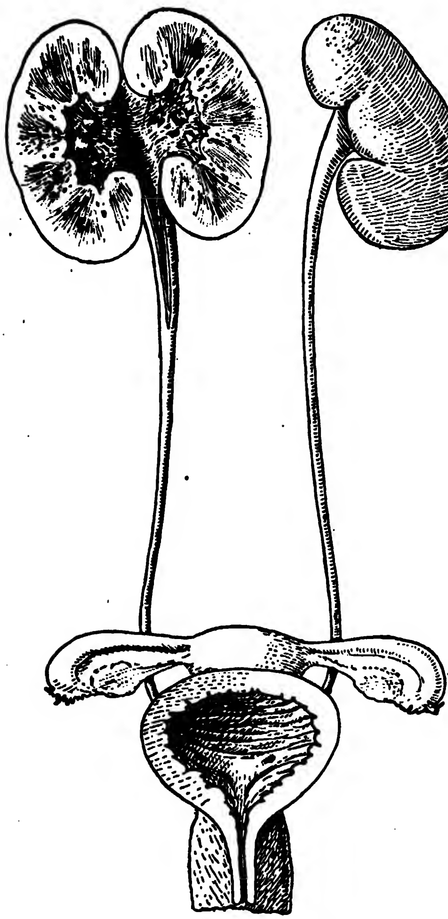


Fig. 4.—Interior View of the Genito-urinary Tract in the Female.

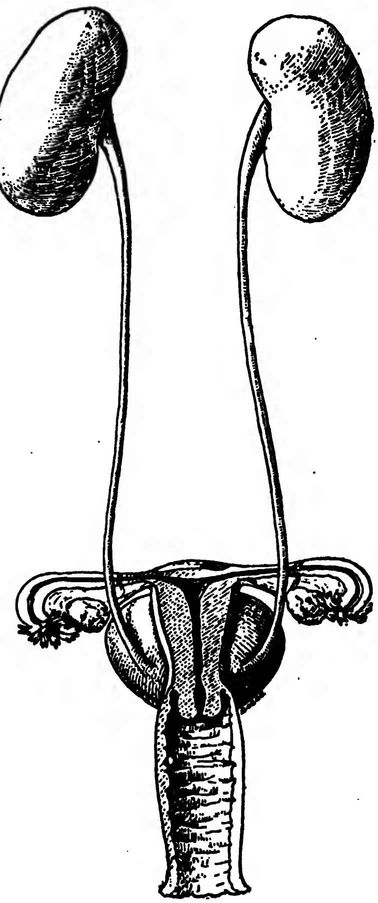


Fig. 5.—Posterior View of the Genito-urinary Tract in the Female.

Fig. 6 shows the side view of the kidney, ureter and bladder in an anterior posterior section as it is found in either man or woman. If this is placed above either the male or the female urethra chart in such a way that the urethral opening of the bladder is placed at the beginning of the urethral canal, it will be seen that the bladder answers for either sex as well as the kidneys and ureters.

Fig. 7 represents a central anterior posterior vertical section through that

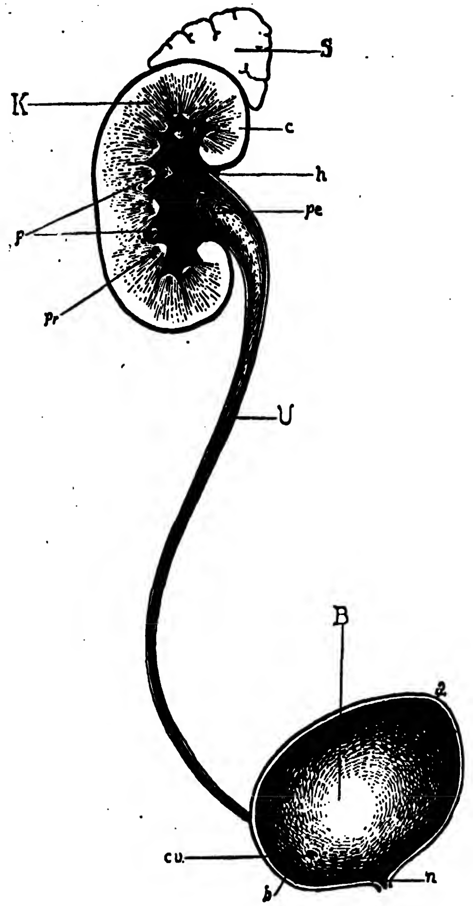


Fig. 6.—Upper and Middle Portions of the Urinary Tract, the Kidney, Ureter and Bladder of Either Sex on Sagittal Section.

S, supra renal capsule.
K, kidney.
p, papillæ.
pr, pyramids.
c, cortex.
h, hilum.
pe, pelvis.
U, ureter.
B, bladder.
a, apex.
n, neck.
b, base.
c.u, cystic orifices of ureter.

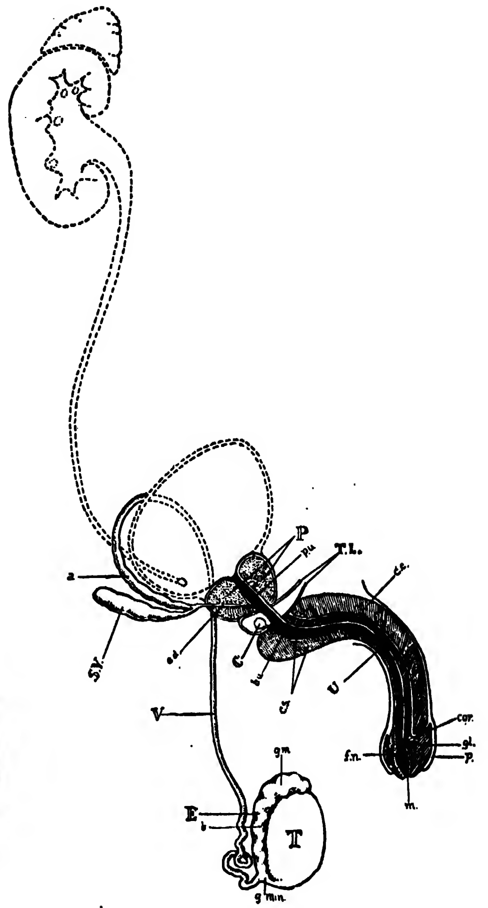


Fig. 7.—Lower Urinary Tract in the Male on Sagittal Section, and also the Internal and External Genital Organs.

V, vas deferens.
S.V., seminal vesicle.
a, ampulla.
c.d, ejaculatory duct.
E, epididymis.
g.m, globus major.
g.min, globus minor.
b, body of the epididymis.
T, testicle.
P, prostate.
T.L., triangular ligament.
C, Cowper's gland.
U, urethra.
p.u, prostatic urethra.
b.u, bulb of urethra.
f.n, fossa navicularis.
c.c, corpus cavernosum.
c.s., corpus spongiosum.
gl, glans penis.
cor, corona.
p, prepuce.
m, meatus.

part of the genito-urinary apparatus of the male that is in common, namely, the penis, prostate and urethra; besides which it shows the male adnexa on one side, that is, the seminal vesicles, vas deferens, epididymis and testis.

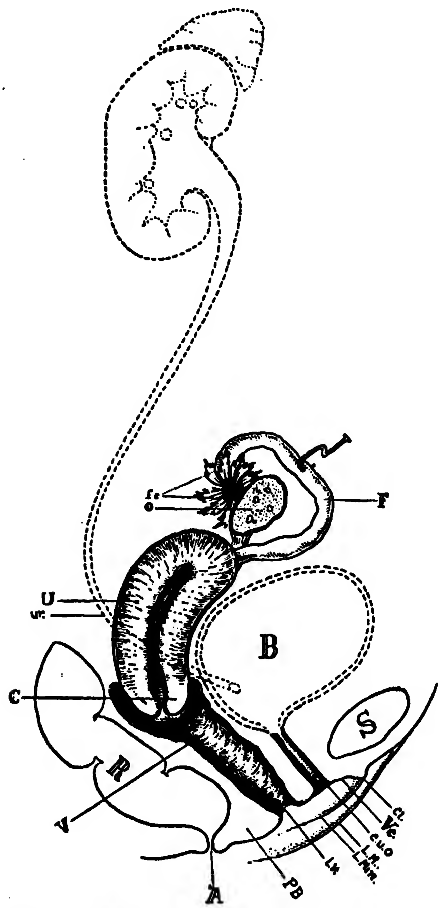


FIG. 8.—GENITAL ORGANS AND LOWER URINARY TRACT IN THE FEMALE ON SAGITTAL SECTION.

F, fallopian tube.
f.e, fimbriated extremity.
O, ovary.
U, uterus.
C, cervix.
B, bladder.
ur, left ureter passing alongside uterus.
R, rectum.
A, anus.
S, symphysis pubis.
V, vagina.
cl, clitoris.
Ve, vestibule.
e.u.o, external urethral orifice.
L.M, labium major.
L.Min., labium minor.
I.V, introitus vaginæ.
P.B, perineal body.

If Fig. 6 was placed on Fig. 7 in such a way that the opening of the bladder was to fit that of the urethra, and the seminal vesicles and the vas deferens with their ampullæ were properly adjusted, they would be seen to lie on the back of the bladder as in Fig. 2.

Fig. 8 depicts an anterior posterior vertical section through the central part of the female genitals, namely, the vestibule, clitoris, vulva, vagina and uterus. There is also a similar section through the urethra in the same line. The Fallopian tube and the ovary are also shown, although somewhat out of position. The place for a dilated bladder corresponding in size with that of Fig. 6 is indicated by dotted lines. If Fig. 6 was placed over Fig. 8 in such a way that the bladder would fit in the space indicated by the dotted lines, it would be seen that the uterus would lie in a plane posterior to the bladder, and that the tubes and ovaries, in case the bladder were empty or but moderately distended, would also lie in a posterior plane.

These figures show the great similarity in the upper three quarters of the urinary tract in the two sexes and also how much closer related the lower quarter of the urinary tract is to the genital in the male than in the female.

This intimate relation in the male has been the reason why the troubles of the genital tract have been called "genito-urinary" in men, instead of "andrological," which would correspond to the term "gynecological" in women.

The urogenital sinus is the point where the urinary tract joins the genital and is differently located in the two sexes.

Fig. 9 shows the urogenital sinus in the male. It is situated in the prostatic urethra at the point where the ejaculatory ducts open into the canal about one inch below the vesical opening.

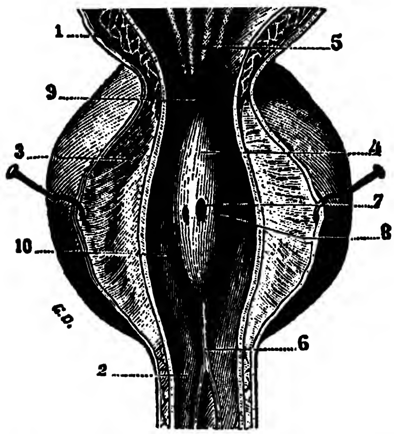


FIG. 9.—GENITO-URINARY SINUS IN THE MALE, THE PROSTATE HAVING BEEN OPENED ANTERIORLY AND ITS LATERAL LOBES RETRACTED. (Testut.)

At this point, the posterior urethra is seen in direct communication with the bladder, and with the ejaculatory ducts.

1, the bladder.
2, urethra.
3, prostate.
4, veru montanum.
5, frenum of the veru montanum.
6, urethral crest.
7, prostatic utricle.
8, orifices of the ejaculatory ducts.
9, prostatic fossette.
10, lateral depressions of the veru montanum.

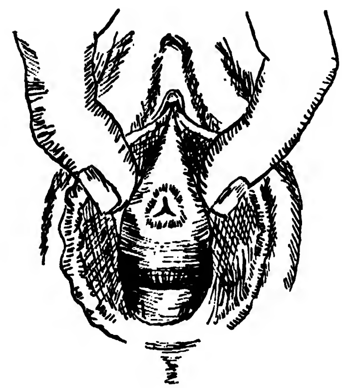


FIG. 10.—GENITO-URINARY SINUS IN THE FEMALE.

The labia minora of the external genitals are seen to be retracted, showing the urethral meatus, the termination of the urinary tract, and just below and behind it the vaginal opening, the termination of the genital tract.

Fig. 10 shows it in the female. It is situated in the vestibule of the vulva, where the urethra and the vagina open.

LOCATION OF THE GENITO-URINARY TRACT

The genito-urinary tract in its whole course has an extensive location, being partly within the body cavity and partly without. The inside part extends from the costal diaphragm to the pelvic diaphragm (levator ani muscle) below, while the outside part is a continuation of the part within through the pelvic diaphragm and the perineum, to end in the external meatus in the male and the vestibule in the female. The bony framework which incloses it may be said to consist of the two lower ribs, the last dorsal and the lumbar vertebræ, and the bones entering into the formation of the pelvis. These are bound together by ligaments, especially important in assisting to make a smooth pelvic cavity out of an irregular bony framework. (See Figs. 11 and 12.)

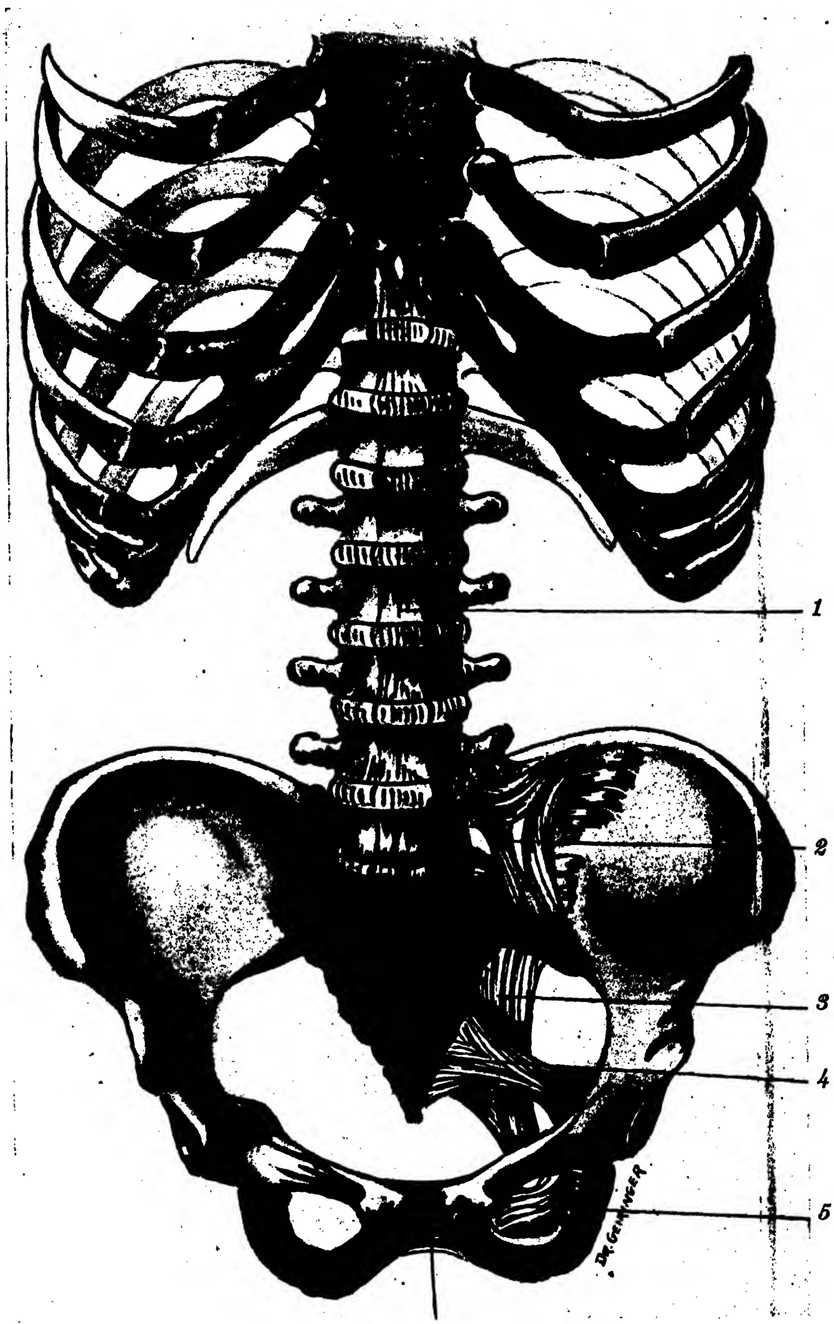


Fig. 11.—Anterior View of the Bony Skeleton of the Part of the Body in Which the Urinary Tract is Lodged.

1, anterior common ligament.
2, ilio-lumbar ligament.
3, greater sacro-sciatic ligament.
4, lesser sacro-sciatic ligament.
5, obturator foramen and membrane.
6, anterior pubic ligament.

Both kidneys and the upper five and one half inches of the ureter are within the abdominal cavity. The bladder, seminal vesicles, the lower four

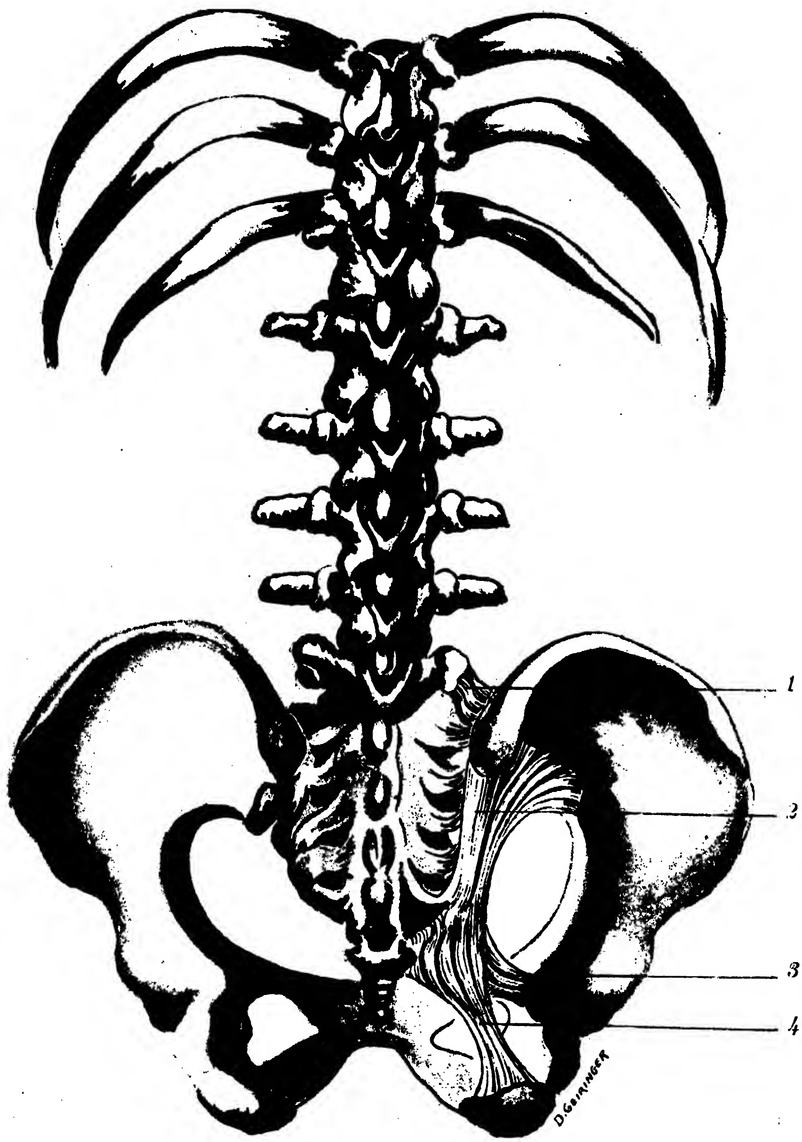


FIG. 12.—POSTERIOR VIEW OF THE BONY FRAMEWORK ENCLOSING THE URINARY TRACT.

1, posterior ilio-lumbar ligament.
2, posterior sacro-iliac ligament.
3, lesser sacro-sciatic ligament.
4, greater sacro-sciatic ligament.

and one half inches of the ureter, the prostate gland, and part of the vas deferens are within the pelvic cavity; while the penis, testicles and part of the

Fig. 13.—Space Occupied by the Urinary Tract after It has been Lined with Its Muscular Layer.

1, diaphragm.
2, inferior vena cava.
3, right crus of diaphragm.
4, pectineus.
5, esophagus.
6, aorta.
7, left crus of diaphragm.
8, quadratus lumborum.
9, transversalis fascia.
10, psoas parvus.
11, iliacus.
12, psoas magnus.
13, pyriformis.
14, coccygeus.
15, obturator externus.
16, obturator membrane.
17, obturator internus.

urethra are outside the body cavity. The kidneys are on the posterior abdominal wall on either side on the last dorsal and upper three lumbar vertebræ. They are behind the peritoneum, and rest behind on the twelfth rib, cruræ of the diaphragm, psoas and quadratus lumborum muscles (Fig. 13). The abdominal portion of the ureter is also behind the peritoneum, lying upon the psoas and running downward and inward as far as the brim of the pelvis.

The intrapelvic and extrapelvic portion of the tract is so intimately related to the various structures in the pelvic cavity and perineum, that, in order to give an adequate idea of their location and relations, a brief description of the pelvis and perineum as a whole must be given.

THE PELVIS

The pelvis consists of a surrounding framework of bones and ligaments, the inner surface of the bones being covered, for the most part, by muscle, while a sheet of muscle arising from either side of the bony wall meets in the middle

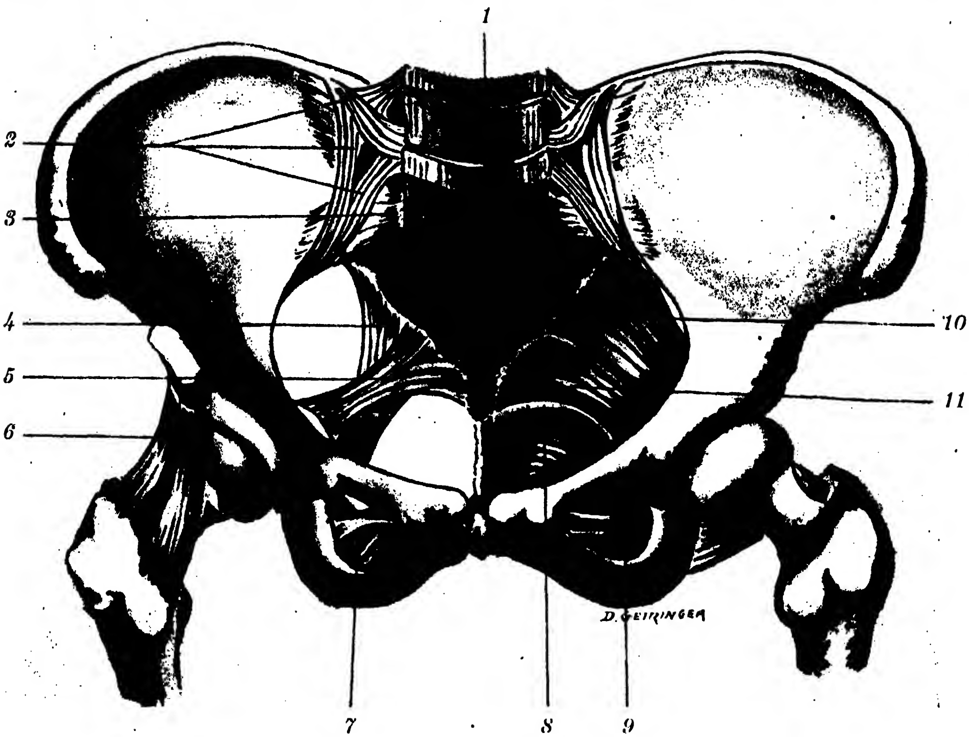


Fig. 14.—The Ligaments Helping to Form the Pelvic Floor on the Right and on the Left, the First Layer of the Muscles Above Covering Them and the Spaces About Them.

1, anterior common ligament.
2, ilio-lumbar ligament.
3, anterior sacro-iliac ligament.
4, greater sacro-sciatic ligament.
5, lesser sacro-sciatic ligament.
6, Y ligament of Bigelow.
7, obturator membrane.
8, levator ani.
9, obturator internus.
10, pyriformis.
11, coccygeus.

line, to close the space below. The muscles are covered with fascia, constituting the various layers described as pelvic fascia. This has attachments to the prostate, bladder, vagina, vesiculæ seminales and rectum, and forms folds which are described as ligaments of these organs. The whole cavity so formed is lined by a complete layer of peritoneum.

The bony wall consists of the sacrum behind and the os innominatum on either side, meeting in front at the symphysis pubis. The ligaments and structures which complete the framework of the pelvis are the sciatic ligaments which extend over the sciatic notch, the obturator membrane closing the obturator foramen, and the triangular ligament which bridges across the space between the rami of the ischium and pubes. These cover the irregular openings in the bony framework, and transform the lower part of the interior into a cylindrical cavity with more or less complete walls, as already mentioned. The muscular structures which pad the inner surface of this framework are the pyriformis and obturator internus. They cover the inner surface of the bones on their lateral and posterior aspects, and obliterate the irregularities of the bony wall, thus rendering the interior a comfortable location for delicate organs.

The space inclosed by these various structures is known as the pelvic cavity, and may be likened to the short segment of a hollow cylinder, deeper behind than in front. It is closed in below by the levator ani and coccygeus muscles, which are known as the pelvic diaphragm, but the coccyx and triangular ligaments must also be looked upon as forming part of the true floor of the space.

Levator Ani.—This arises from the back part of the pubic bone from a line of fascia (white line, Figs. 15–16) extending from the back part of the pubes and from the inner surface of the ischial spine. The anterior fibers extend downward and inward by the side of the prostate, meeting those of the opposite side. The intermediate fibers slope downward and inward and support the rectum and bladder. At the junction of the rectum and anal canal, they form a collar round the gut, which extends downward on its lateral walls as far as the external sphincter. The posterior fibers are inserted into the anococcygeal raphe and the sides of the coccyx (Fig. 15). In the female, that portion of fibers which surrounds the prostate in the male are attached on either side to the vaginal wall. The nerve supply for this muscle comes from the fourth and fifth sacral, some branches of the same nerves going to the coccygeus.

Coccygeus Muscle.—This is a small fan-shaped muscle which arises from the spine of the ischium, extending backward and inward to be attached to the sides and anterior surface of the coccyx. The levator ani and coccygeus thus form one continuous sheet of muscle, which make, as it were, a bed and support for the viscera (Fig. 16). They are both the remains of the tail

muscles. In quadrupeds the various components of the levator ani arise from the brim of the pelvis, and are inserted into the coccyx or caudal vertebræ.

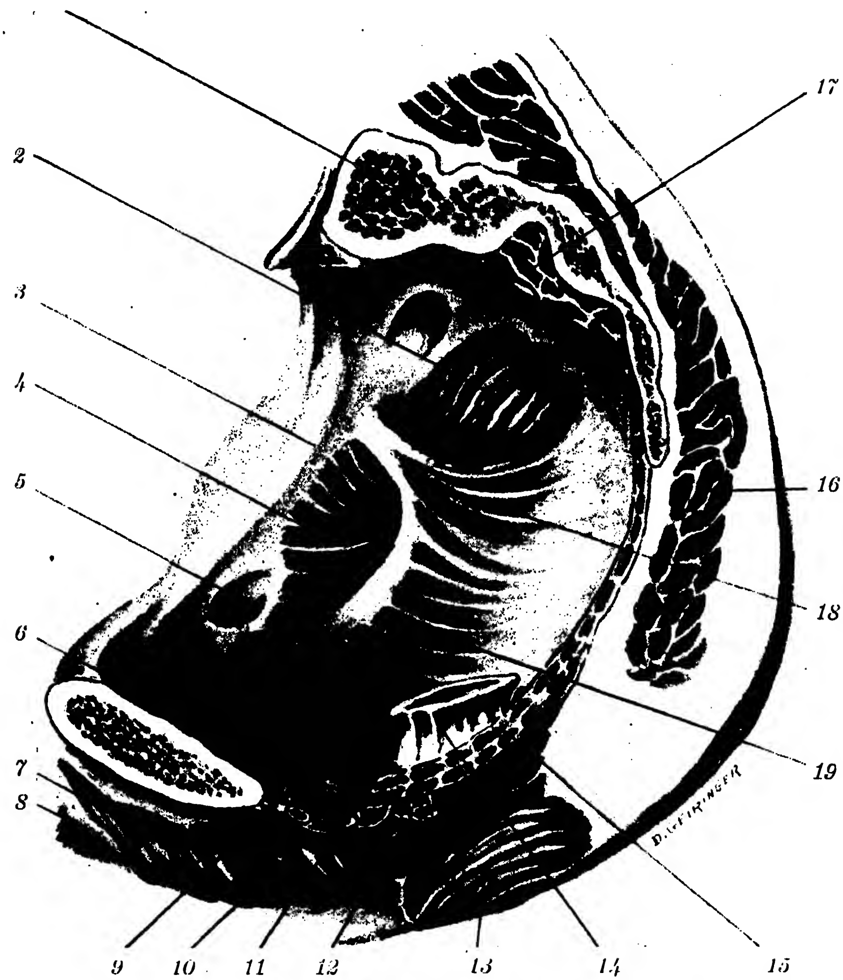


FIG. 15.—VIEW OF THE RIGHT SIDE OF THE PELVIC CAVITY AS SEEN AFTER A SAGITTAL SECTION

The sacrum is seen above and the pubis below, while between are the muscles and fascias goin make up the pelvic walls and floor. The urethral orifice is seen just behind the pubis and behind the stump of the rectum; extending from the coccyx to the pubic bone the levator is seen.

1, cut surface of the sacrum.
2, pyriformis.
3, ilio-pectineal line.
4, obturator internus.
5, obturator foramen.
6, urethral opening.
7, bulbo-cavernosus muscle.
8, corpus spongiosum.
9, deep layer of triangular ligament.
10, superficial layer of triangular ligament.
11, Cowper's glands.
12, transversus perinei muscle.
13, sphincter ani externus.
14, rectum.
15, levator ani cut through.
16, gluteus maximus.
17, pyriformis.
18, coccygeus.
19, levator ani.

With the assumption of the upright posture, the muscles become modified to form one sheet, their origin sinks downward, while they acquire their various

insertions and increase in strength, to support the viscera which tend to sink downward from gravity, the effect of gravity being markedly increased in the upright position. In man, traces of the former attachment of these muscles

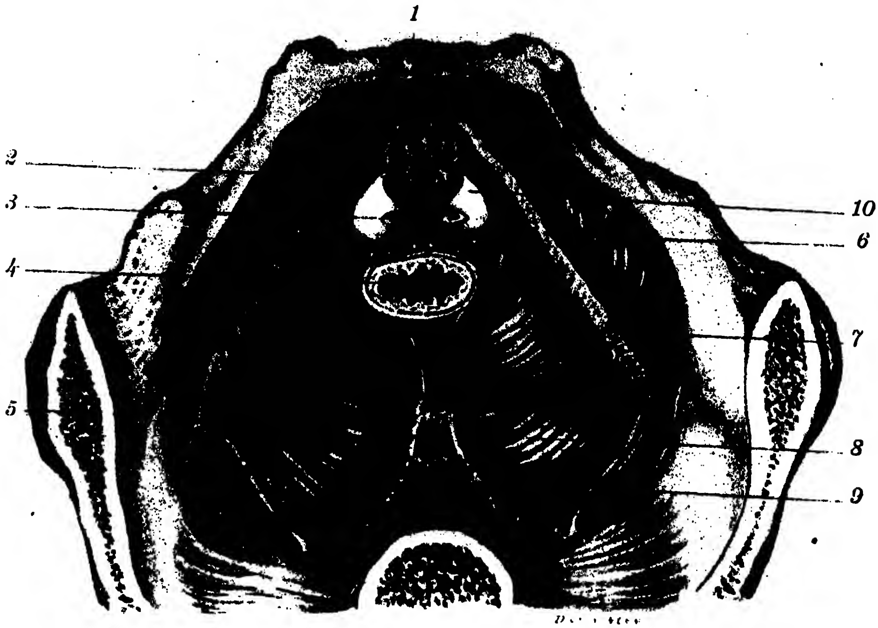


FIG. 16.—THE PELVIC FLOOR LOOKING IN FROM ABOVE.
The pubis is seen in front, the vertebra behind and the ilium and pubes on either side.

1, symphysis.
2, prostatic urethra.
3, seminal vesicles.
4, rectum.
5, cut surface of iliac bone.
6, obturator internus.
7, levator ani muscle.
8, coccygeus.
9, pyriformis.
10, prostate gland.

can often be found. The coccygeus and small sciatic ligaments are the representatives of the ischio coccygeus, the lateral flexors of the tail in lower animals (Keith's "Embryology").

Pelvic Fascia.—This can be best understood by considering the development of fascia in general. This structure is never developed in sheets, as is so commonly described, but is merely the portion of mesoblast left over after structures have formed within it. Thus we see that fascia must form a continuous attenuated spongework, in which the interstices are filled with structures which have become differentiated. We can now understand the intimate relations of the fascia covering the levator and its connections with the prostate gland, bladder, the vesiculæ seminalis, uterus, vagina and rectum. With the above considerations in mind, we see that the parietal layer of pelvic fascia, so called, is merely the internal sheath of the pyriformis and obturator internus muscles. The visceral layer, laterally and behind, is the upper portion of the sheath of the levator ani, while in front the visceral layer is really the

posterior layer of the triangular ligament, which is itself the posterior portion of the sheath of the compressor urethra. The fibrous covering of the prostate, bladder, vesiculæ seminales, vagina, uterus and rectum are thus continuous with these muscle sheaths, and form the fascia described as the vesical, recto-vesical, and rectal layers of pelvic fascia (Fig. 17). The internal and external capsules of the prostate are so called because a partial line of cleavage has been made by blood vessels developing in the mesoblastic spongework. The

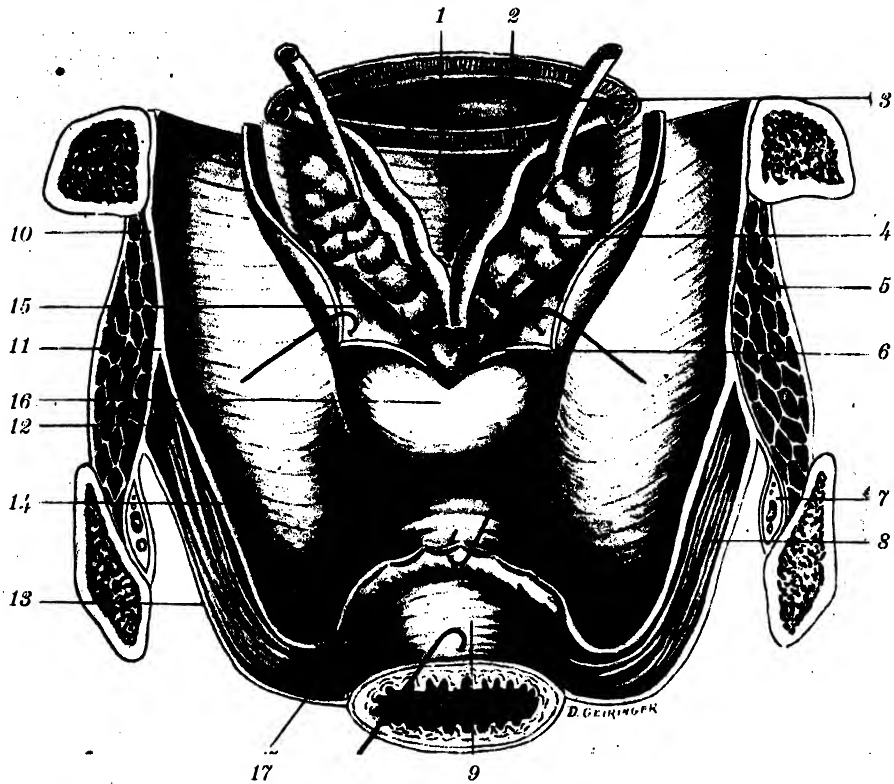


FIG. 17.—VIEW OF THE INTERNAL GENITALS AND THE PELVIC FASCIA IN THE MALE AS SEEN FROM BEHIND, AFTER THE RECTUM HAS BEEN SEPARATED AND PULLED DOWN.

1, bladder.
2, vas deferens.
3, ureter.
4, seminal vesicle.
5, obturator internus muscle.
6, prostate.
7, Alcock's canal.
8, levator ani muscle.
9, rectum drawn down.
10, pelvic fascia.
11, white line fascia.
12, obturator fascia.
13, anal fascia.
14, recto-vesical fascia covering levator ani muscle.
15, recto-vesical fascia split and reflected from bladder, prostate and seminal vesicles.
16, recto-vesical fascia forming capsule of prostate.
17, recto-vesical fascia reflected from rectum.

anal fascia covering the perineal surface of the levator ani is merely the sheath of the under surface of the muscle.

Peritoneum.—Internal to the fascial lining of the pelvic cavity is a complete covering of peritoneum. This lines the sides of the pelvis, being contin-

uous with the peritoneal lining of the abdominal cavity, and is reflected on to the floor of the space, covering more or less of the pelvic viscera (Fig. 18). The peritoneal coverings can be best understood by imagining the peritoneum as extending down into the pelvic cavity as a closed sac, and the viscera as having been pushed up from below, evaginating portions of the bottom of the

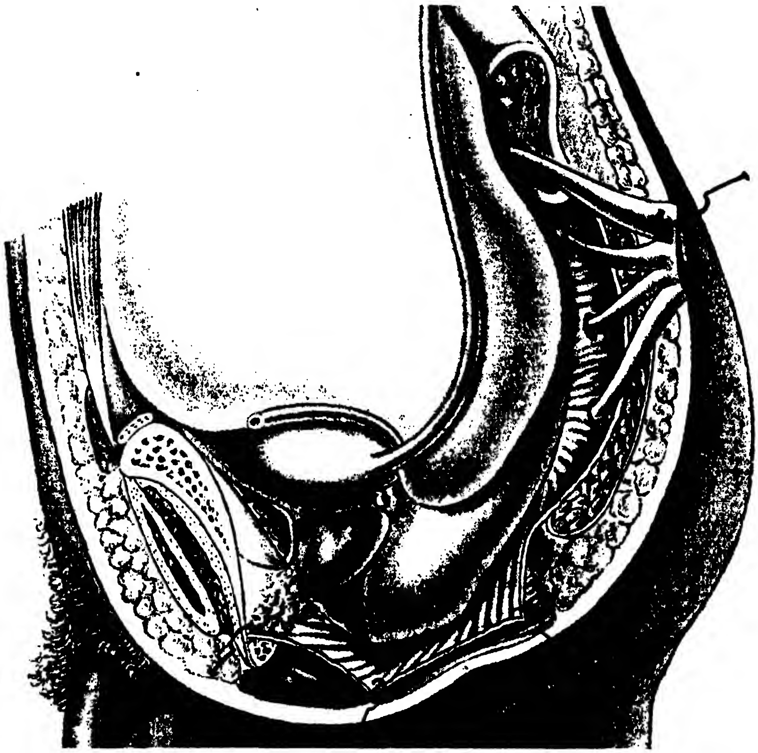


FIG. 18.—EXTRAPERITONEAL SAGITTAL SECTION OF THE BODY TO THE LEFT OF THE MEDIAN LINE. The ureter is seen extending down until it enters the bladder. The vas deferens with the peritoneum above and extraperitoneal portion of the bladder below is seen running horizontally toward the ureter and passing in front of it to become an ejaculatory duct. The prostate is seen below the bladder and between its base and the ureter on the posterior wall of the bladder the stump of the seminal vesicle is seen.

sac and not having been pushed up far enough to get complete coverings. Thus the bladder is covered on its superior surface as far as the apex, on the upper part of the lateral surface, and covering over the basal surface far enough to cover one third of the vesiculæ seminales. In front, from the apex of the bladder, it is reflected on to the anterior abdominal wall. Behind from the base of the bladder it passes backward on to the rectum in the male, forming the recto-vesical pouch. In the female, it covers the uterus above, in front and behind, the two layers meeting laterally to form the broad ligament. From the uterus it is reflected on to the rectum, forming the utero-sacral pouch or pouch of Douglas. It covers the middle third of the rectum on the anterior

surface, extending backward and upward over the sides to the upper third, which is covered in front and on the side, thence blending with the parietal layer.

The blood vessels in the pelvis run beneath the peritoneum. The larger trunks, internal iliac and its lateral branches, are found on the side wall of the pelvis, superficial to the fascia, while the visceral branches run inward to their distribution between the peritoneum and fascia. The sacral nerves, with the exception of the obturator, are found beneath the fascia, the obturator is superficial, running beneath the peritoneum, and leaves the pelvis through a special opening in the parietal fascia at the upper part of the obturator foramen.

THE PERINEUM

The perineum is a lozenge-shaped space between the pelvic floor above and the cutaneous surface below. It is bounded on the sides by the rami of the pubes and ischium, the ischial tuberosity, and the great sciatic ligament, in front by the symphysis pubis and behind by the coccyx. The superficial fascia covering this space presents certain characteristics of surgical importance (Fig. 19). It is fatty behind, muscular in front, where it extends over the scrotum, the muscular fibers being known as the dartos, and accounts for the rugosities in the skin of the scrotum. The middle portion is divided into two layers, the superficial layer, continuous with the superficial fascia of surrounding parts, and a deep layer known as the fascia of Colles. This is attached on either side to the pubic arch and behind winds round the posterior border of the transversus perinei muscle to form a firm attachment to the anterior layer of the triangular ligament. In front it is continuous with the fascia of Scarpa on the anterior abdominal wall. This fascial connection is very important, as it determines the direction of extravasated urine in cases of rupture of the urethra anterior to the triangular ligament. The perineal space is arbitrarily divided into two portions by a line extending transversely across the space between the two ischial tuberosities. This line passes just in front of the rectum, and forms the urogenital triangle in front and the rectal triangle behind.

The Rectal Triangle.—This contains the rectum with its sphincter muscles, and on either side of it is the ischio-rectal fossa. The latter is a pyramidal-shaped space filled with fat which is derived from the superficial fascia. Crossing the space from without inward, are the inferior hemorrhoidal vessels and nerves, which come off from the internal pudic artery and nerve as they lie on the inner surface of the ischium, in the fascial sheath known as Alcock's canal. The fourth sacral nerve is found in the posterior part of the space, while the two superficial perineal nerves arise from the internal pudic and run a short distance in the anterior part of the space before they pierce the triangular ligament and enter the urogenital triangle.

The Urogenital Triangle.—The two layers of the superficial fascia having been described, we come next to the various muscles beneath this, which meet in the central part of the triangle. This is called the central point of the

FIG. 19.—MUSCULAR LAYER OF THE PERINEUM ON THE RIGHT SIDE AFTER THE REMOVAL OF THE SUPERFICIAL FASCIA.

On the left side the muscular layer has been removed, showing the corpus spongiosum with its bulb and the roots of the corpora cavernosa, whereas below the superficial layer of the deep fascia (the triangular ligament) is seen.

1, bulbo-cavernosus (accelerator urinæ) muscle.
2, ischio-cavernosus or erector penis muscle.
3, ischio-cavernosus or erector penis muscle.
4, transversus perinei.
5, anus.
6, sphincter ani externus.
7, corpus spongiosum.
8, corpus cavernosum.
9, Colles' fascia reflected.
10, adductor muscle of thigh.
11, cut surface corpus cavernosum muscle.
12, anterior or superficial layer of triangular ligament.
13, tuber ischii.
14, obturator internus.
15, levator ani.
16, gluteus maximus.
17, coccyx.

perineum, or perineal body. It is merely a fibrous septum situated a little in front of the anus, into which are attached the anterior portion of the sphincter ani, the bulbo-cavernosus, the anterior fibers of the levator ani, and the transversus perinei muscles.

Sphincter Ani.—The sphincter ani is a band of muscle fibers extending from the coccyx behind to the perineal body in front. It forms a muscular collar round the lower part of the anal canal.

Transversus Perinei.—These fibers extend from the ascending ramus of the ischium near the tuberosity horizontally inward to be attached to the central point of the perineum.

Fig. 20.—Anterior Perineal Triangle after the Removal of the Muscles, the Corpus Spongeosum and the Corpora Cavernosa Covering It.

The urethra is seen near the middle of the triangle.

1, corpus spongiosum.
2, corpus cavernosum.
3, dorsal vein to penis.
4, dorsal artery to penis.
5, adductor muscle of thigh.
6, superficial layer triangular ligament.
7, artery, vein and nerve to bulb.
8, sphincter ani externus.
9, levator ani.
10, gluteus maximus.
11, urethra.
12, tuber ischii.
13, anus.
14, urethra.

Bulbo-cavernosus.—The bulbo-cavernosus is a muscular sheet covering the bulb and extending on to the corpus spongiosum. It arises from the central point of the perineum, and from a tendinous septum formed by the union of

the two muscles. Some of the fibers completely encircle the bulb, meeting those of the opposite side; others extend forward and enclose the corpora cavernosa; while the posterior fibers are attached directly to the triangular ligament.

Ischio-cavernosus Muscles.—These muscles arise on either side from the inner surface of the ischial tuberosity. They extend forward, completely cov-

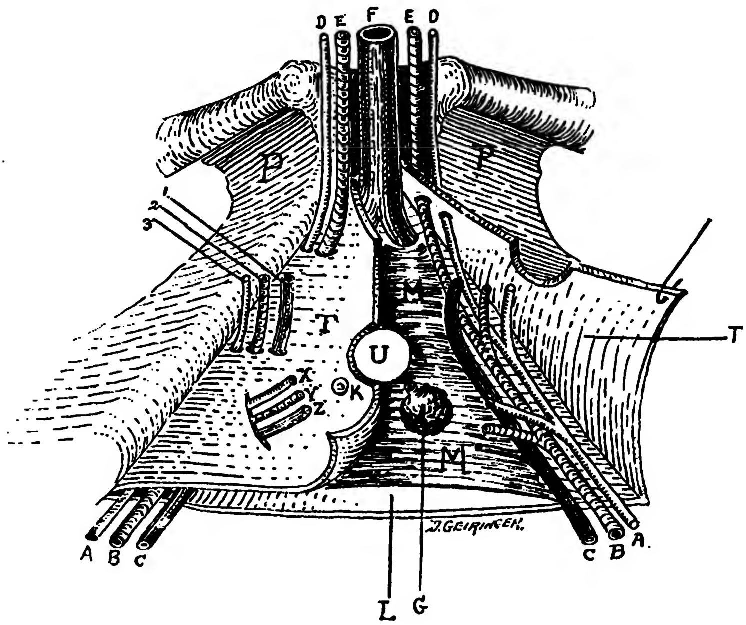


Fig. 21.—The Outer Layer of the Triangular Ligament on the Right Side, and on the Left the Space Between the Two Layers of the Ligament.

D, dorsal nerve of penis.
E, dorsal artery of penis.
F, dorsal vein of penis.
U, urethral opening.
T, anterior layer of triangular ligament.
L, posterior layer of triangular ligament.
M, compressor urethræ muscle.
G, Cowper's gland.
K, duct of Cowper's gland.
A, internal pudic nerve.
B, internal pudic artery.
C, internal pudic vein.
1, vein of corpus cavernosum.
2, artery of corpus cavernosum.
3, nerve of corpus cavernosum.
X, nerve of bulb.
Y, artery of bulb.
Z, vein of bulb.
P, pubic rami.

ering the crura of the penis and are attached to the corpora cavernosa. These various muscles divide the urogenital triangle into two lesser perineal triangles, the boundaries of which are the bulbo-cavernosus muscles on either side and the transversus perinei muscles behind (Fig. 19). At the bottom of this perineal triangle is found a dense fibrous structure on which these muscles seem to rest. This fibrous structure is the anterior layer of the triangular ligament (Fig. 20). As we have seen before, this is on the same plane with the bony wall of the pelvis, and is attached firmly to the rami of the pubes and ischium,

while behind it receives a firm attachment to the fascia of Colles (Fig. 20). It is perforated at its posterior part by the urethra, and a short distance on either side of this the artery of the bulb comes through. About half an inch in front of the urethral opening, it is pierced by the internal pudic artery and dorsal nerve of the penis, while the superficial perineal vessels and nerves enter

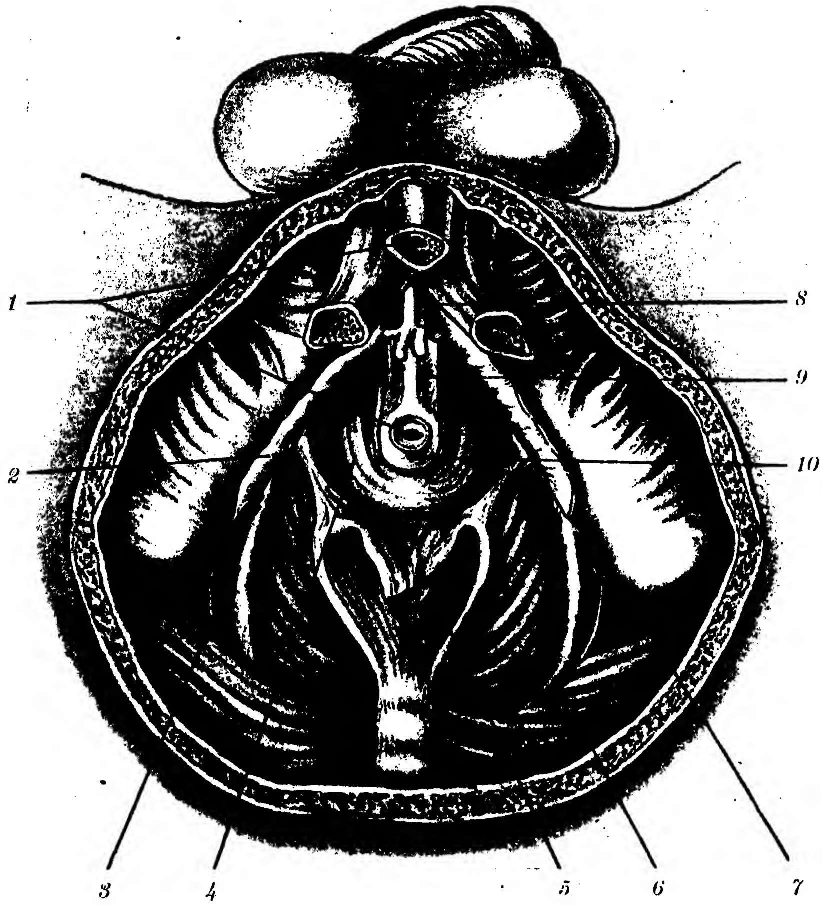


FIG. 22.—THE MALE PERINEUM AFTER THE REMOVAL OF THE DEEP LAYER OF THE TRIANGULAR LIGAMENT.

Here we see the other side of the levator ani muscle to that shown in Fig. 16.

1, urethra.
2, triangular ligament.
3, obturator internus muscle.
4, levator ani muscle.
5, sphincter ani externus.
6, gluteus maximus.
7, great sacro-sciatic ligament.
8, dorsal vein of penis.
9, recto-vesical fascia.
10, capsule of prostate gland.

the urogenital triangle by piercing its base (Fig. 21). The deep or superior layer of the triangular ligament, as we have seen, is merely a portion of the pelvic fascia, but between the so-called superior and the anterior or triangular ligament proper is a definite space. The structures found in this interval are

the urethra, surrounded by the compressor urethræ muscles, Cowper's glands, the internal pudic artery and dorsal nerve of the penis, the artery to the bulb, and the dorsal vein of the penis which has entered this space by passing back-

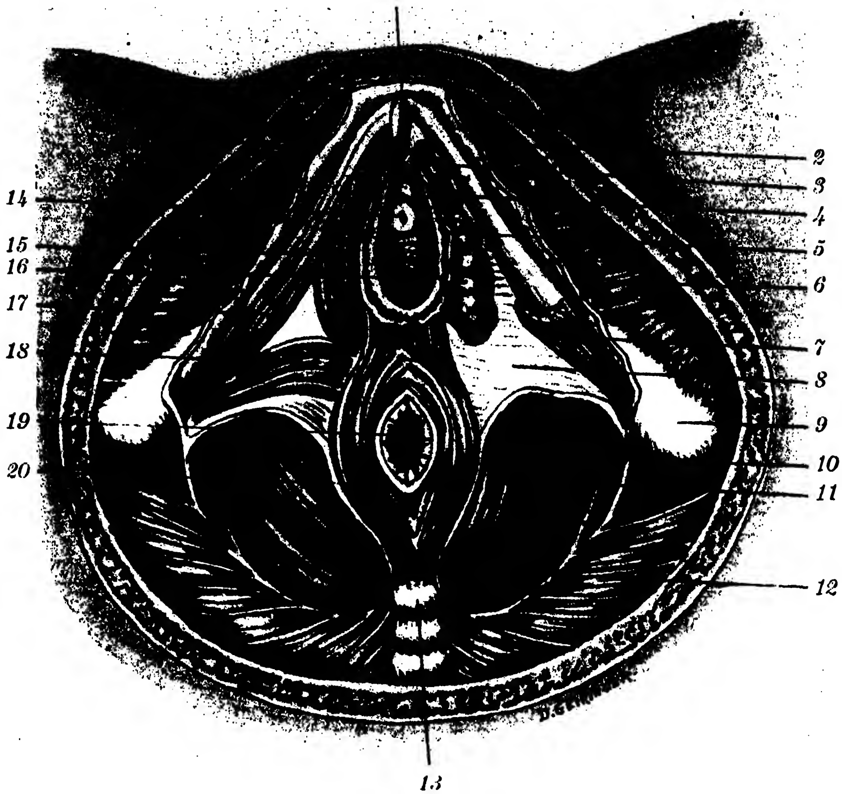


Fig. 23.—The Perineum in the Female after the Removal of the Labia.

On the right beneath the deep layer of the superficial fascia the muscular layer is seen, and on the left side, after removing the muscular layer, the corpus cavernosum, vaginal bulb and the superficial layer of the triangular ligament are seen.

1, clitoris.
2, Colles' fascia reflected.
3, bulb of vagina.
4, corpus cavernosum.
5, opening of vagina.
6, adductor muscle.
7, cavernosum muscle—ischio-cavernosus.
8, superficial layer of triangular ligament.
9, tuber ischii.
10, levator ani.
11, obturator internus.
12, gluteus maximus.
13, coccyx.
14, urethral opening.
15, ischio-bulbosus (sphincter vaginæ).
16, vagina.
17, corpus cavernosus muscle.
18, transversus perinei.
19, anus.
20, sphincter ani externus.

ward through a small opening between the anterior triangular ligament and the subpubic ligament (Fig. 21).

Compressor Urethræ.—This arises from the inner side of the ischio-pubic rami on either side, the two muscles meeting in the mid line and inclosing the urethra. The larger body of the muscle is inserted behind the urethra.

Just below this muscle is a group of muscle fibers arising from the ramus of the ischium and continuous with the compressory urethra at its insertion; this is called the transversus perinei profundus. Sometimes muscular fibers (compressor venæ dorsalis) from the anterior portion of the bulbo-cavernosus muscle pass obliquely outward and forward, inclosing the entire circumference of the root of the penis and the dorsal vessels.

Internal Pudic Artery.—The internal pudic artery arises from the anterior division of the internal iliac, passing out of the pelvis through the small

Fig. 24.—Anterior Layer of the Triangular Ligament in the Female, after the Removal of the External Genitals, the Superficial Fascia and Muscles.

The urinary and vaginal passages are seen. It corresponds to Fig. 20 in the male.

1, urethral opening.
2, vagina.
3, tuber ischii.
4, adductor muscles of thigh.
5, superficial layer of triangular ligament.
6, levator ani.
7, sphincter ani externus.
8, gluteus maximus.
9, coccyx.

sciatic notch; it crosses over the spine of the ischium and enters the perineal space, running along the ischial tuberosity in the fascial sheath known as Alcock's canal. This is situated about an inch and a half from the lower border of the ischial tuberosity. It ascends to the inner surface of the ramus of the pubes, and about one half inch below the symphysis pubis pierces the triangular liga-

ment and is continued onward to the dorsal artery. Its branches are inferior hemorrhoidal, superficial and transverse perineal, artery to the bulb, and artery to the corpus cavernosus.

Internal Pudic Nerve.—This arises from the sacral plexus and follows the same course as the artery, the nerve being situated usually above. As it passes over the ischium, it divides into two branches, the perineal, and dorsal nerves of the penis. The perineal nerve breaks up to supply the small perineal muscles previously described, and the two superficial perineal nerves supply the skin over the part as far forward as the scrotum. The dorsal nerve of the penis is contin-

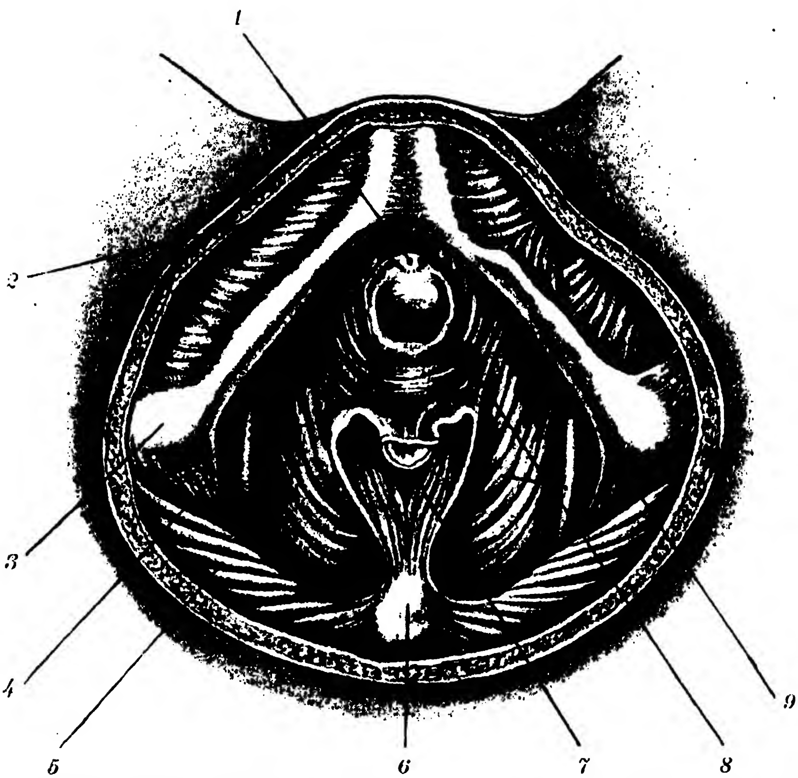


Fig. 25.—The Deep Layer of Muscles Forming the Floor of the Pelvis in the Female from the Outside.

The urethral and vaginal openings are seen. It resembles Fig. 22 in the male.

1, urethra.
2, adductors.
3, tuberosity of ischium.
4, obturator internus.
5, gluteus maximus.
6, coccyx.
7, sphincter ani.
8, levator ani.
9, great sacro-sciatic ligament.

ued onward with the internal pudic artery and dorsal artery of the penis. Fig. 22 shows a deep dissection of perineum after removal of triangular ligament.

Female Perineum.—In the female the perineum is divided into urogenital and rectal triangles, as in the male. The rectal triangle does not differ in any

way from that found in the male. In the urogenital triangle the vagina makes some alteration in the relation of the parts. The ischio-bulbosus muscle is found in two separate parts covering over the bulb as it lies at the sides of the vagina (Fig. 23). The vagina also makes a cleft in the triangular ligament, which structure in the female is of less density than in the male (Fig. 24).

Fig. 25 shows a deep dissection of female perineum after removal of triangular ligament.

THE KIDNEYS

The kidneys are the glands which secrete the urine. They are situated on the posterior abdominal wall behind the peritoneum, between the upper border

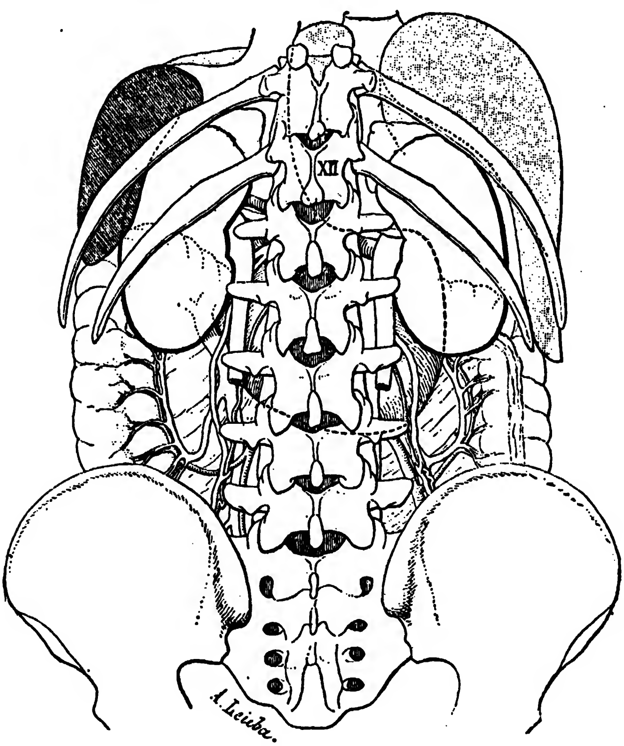


Fig. 26.—The Posterior Surfaces of the Kidneys and their Relations to the Ribs. (Recamier.)

of the twelfth dorsal and middle of the third lumbar vertebræ (Fig. 26). The right kidney extends to the lower border of the eleventh rib; the left is placed somewhat higher, and its upper pole may rest on the eleventh rib. Below, they are both separated by a short interval from the crest of the ileum. The kidney is a bean-shaped body, four and one half inches (11.2 cm.) in length, two and one half inches (6.2 cm.) in breadth, and one and one half inches (3.7 cm.) in thickness. Its weight is about four and one half ounces.

Relations of the Kidney.—The kidney has an anterior or visceral surface, a posterior or muscular surface, an internal border or hilus, and an external border. The upper and lower ends of the kidney are called respectively the upper and lower poles.

The *anterior surface* of the kidney looks forward and slightly outward, and is partly covered by peritoneum. On the right side, it is in relation above with

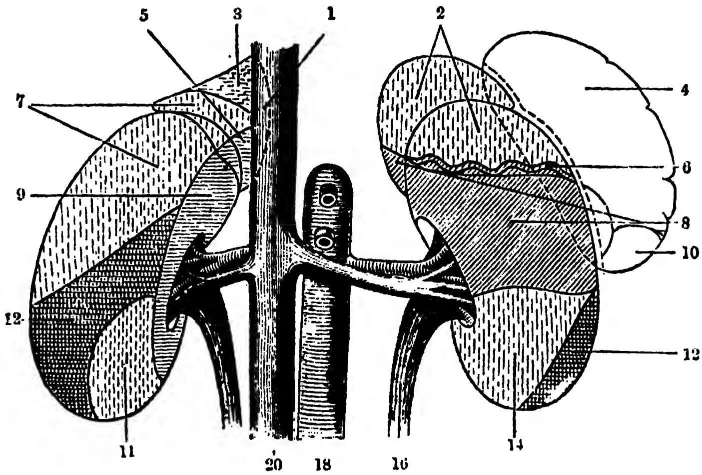


FIG. 27.—THE RELATION OF THE KIDNEYS AND SUPRARENAL CAPSULES TO THE TISSUES IN FRONT OF THEM. (Morris.)

1, caval area.
2, gastric area (peritoneal).
3, hepatic area (nonperitoneal).
4, gastric area of spleen.
5, duodenal area (nonperitoneal).
6, splenic artery.
7, hepatic area (peritoneal).
8, pancreatic area (nonperitoneal).
9, duodenal area (nonperitoneal).
10, colic area of spleen.
11, mesocolic area.
12, colic area (nonperitoneal).
14, mesocolic area.
16, ureter.
18, aorta.
20, vena cava.

the right suprarenal body, which extends farther down the anterior surface on the right than on the left (Fig. 27). The outer three fourths of the upper half of the kidney lies behind the liver and is covered by peritoneum. The outer three fourths of the lower half, just below the hepatic area, is behind the ascending colon and the mesocolic area and is not covered by peritoneum beneath the colon. The inner quarter of the organ is behind the duodenum, and is nonperitoneal as is its colic area. The small area on the internal aspect of the anterior surface of the upper third of the kidney is in relation with the inferior vena cava.

The anterior surface of the left kidney is in relation above, for a small space, with the left suprarenal (Fig. 27). The upper fifth of the anterior surface lies behind the stomach, and is covered by peritoneum. The middle two fifths is behind the pancreas, nonperitoneal. The lower two fifths lies behind the colon and mesocolon, the latter being peritoneal. A narrow strip of the

anterior surface in its outer part is in apposition with the renal surface of the spleen, and connected to this organ by the lieno-renal ligament.

The *posterior surface* on both sides in its upper third rests upon the diaphragm, the twelfth rib crossing behind this (Fig. 28). Between the diaphragm and the lower ribs, the pleura extends for a considerable distance behind the kidney. The inner third of the lower two thirds lies upon the psoas, the middle third on the quadratus lumborum, and the outer third rests upon the tendon of the transversalis. The last dorsal ilio-hypogastric and ileo-inguinal nerves pass in a direction downward and outward behind the kidney on both sides. The external arcuate ligament and transverse processes of the upper three lumbar vertebræ lie immediately behind the muscular bed of the kidney.

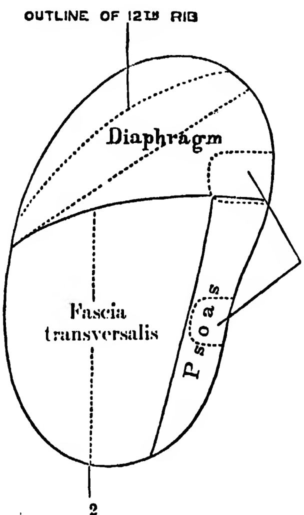


FIG. 28.—THE RELATION OF THE KIDNEYS TO THE TISSUES BEHIND THEM. (Morris.)

1, transverse processes of the first and second lumbar vertebræ.

2, line indicating outer border of quadratus lumborum.

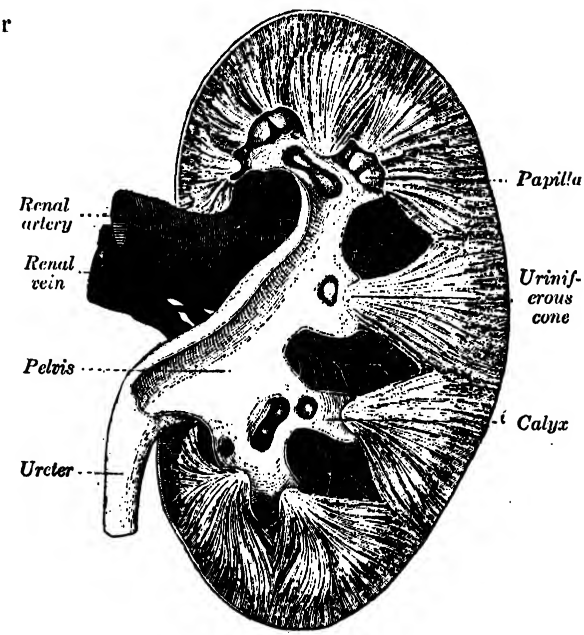


FIG. 29.—MEDIAN VERTICAL SECTION OF THE RIGHT KIDNEY. (Poirier.)

The renal artery and vein, the interior of the pelvis, calices, the ureter, the papillæ and pyramids are seen.

The *inner border* of the kidney in its middle part consists of an anterior and posterior lip, forming a fissure which is known as the hilum. In a space between these lips, which extends into the kidney substance for a short distance, is the renal sinus, and here the blood vessels and ureter enter the kidney (Fig. 29). These vascular structures are known as the pedicle.

The relations from before backward are vein, artery, ureter. From above downward the relation is artery, vein, ureter. The upper pole of the kidney supports the suprarenal body posteriorly. It is in relation with the inner sur-

face of the twelfth rib, or on the left side may lie in front of the eleventh. The diaphragm and pleura intervene between the kidney and the bone. The lower pole reaches about two inches from the iliac crest and is situated farther from the median line than the upper pole.

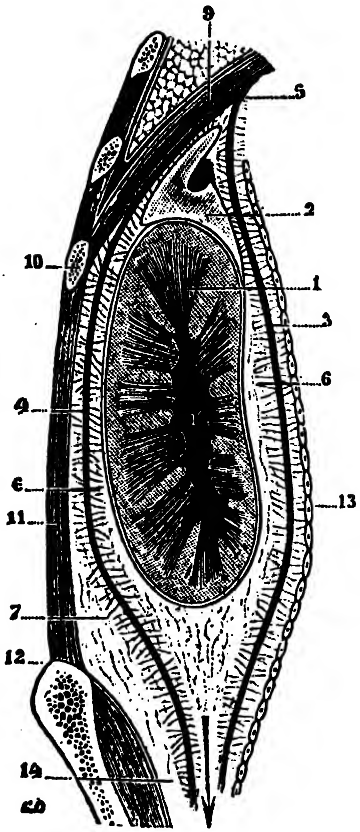


FIG. 30.— THE RENAL FASCIA AFTER A SAGITTAL INCISION THROUGH THE KIDNEY. (Testut and Jacob.)

1, kidney with its sinus.
2, suprarenal capsule.
3, perirenal fascia in front of kidney.
4, perirenal fascia behind kidney.
5, common insertion of its two leaves into the diaphragm.
6, fatty capsule.
7, pararenal fascia.
8, opening below the two layers of perirenal fascia.
9, diaphragm.
10, twelfth rib.
11, quadratus lumborum muscle.
12, crest of ilium.
13, parietal peritoneum.
14, adipose and cellular tissue in the iliac fossa.

The *external border* of the kidney is formed by the meeting of the anterior and posterior surfaces, and rests upon the tendon of the transversalis. The kidney is closely invested by a fibrous capsule, which, winding round the lips of the hilum, lines the renal sinus and also sends prolongations over the vessels and ureter.

The Pelvis of the Kidney.—This arises from the kidney sinus by a series of small tubes, eight to twelve in number, called calices, surrounding one or more papillæ. These fuse into one, two or three larger ducts, which in turn unite to form the pelvis. This cone-shaped duct extends inward and downward, decreasing rapidly in size to become continuous with the upper end of the ureter (Fig. 29).

Perirenal Tissue.—When the kidney develops, it grows out as an evagination from the Wolffian duct. This diverticulum extends into the surrounding mesoblastic tissue, a portion of which becomes differentiated to form the kidney cortex. The part of the mesoblast that remains outside the cortex forms the perirenal tissue. This remaining spongework becomes filled with fat and surrounds the kidney, being thickest above, behind and externally. As we see from this mode of formation, no special ligaments are developed to hold the kidney in place, although by special dissection some of the fibrous tissue may be described as such.

This surrounding tissue above is carried upward to the diaphragm (Fig. 30), internally over the spinal column (Fig. 31) to the opposite kidney, while below it extends on the posterior abdominal wall as far as the iliac fossa.

Below it does not form so markedly a closed sac as it does over the upper part of the kidney. This is due to the fact that the kidney originates below and travels upward as it develops. The chief agents in maintaining the kidney in its normal position are the intra-abdominal pressure, the attachments to the various viscera, and to some extent the perirenal tissue.

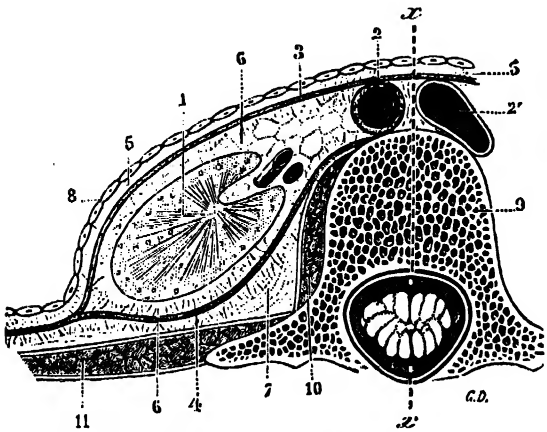


FIG. 31.—THE RENAL FASCIA AFTER A HORIZONTAL INCISION THROUGH THE KIDNEY. (Testut.)

XX, the median line.
1, the kidney.
2, aorta.
2', inferior vena cava.
3, perirenal fascia.
4, posterior leaflet of perirenal fascia.
5, anterior leaflet of perirenal fascia.
6, *6*, fatty capsule.
7, pararenal fat.
8, parietal peritoneum.
9, vertebra.
10, psoas muscle with its aponeurosis.
11, quadratus lumborum with its aponeurosis.

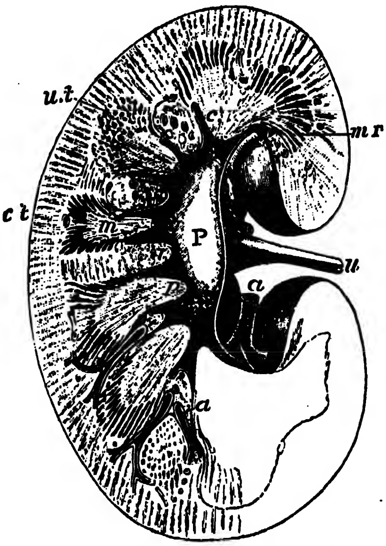


FIG. 32.—SAGITTAL SECTION OF THE KIDNEY. (Henle.)

u.t, uriniferous tubes.
c.t, cortex with pyramids of Ferrein.
m, pyramids of Malpighi.
i, column of Bertini.
p, papilla.
c, calyx embracing papilla.
m.r, medullary rays.
P, pelvis.
u, ureter.
a a, artery.

Structure.—The kidney on section shows an outer cortical layer called the cortex, and an inner called the medulla (Fig. 32). The medulla consists of pyramidal masses, eight to twenty in number, with their base toward the cortex, called pyramids of Malpighi. Their apices form small prominences (renal papillæ) which project into the renal calices, and contain the orifices of the kidney tubules. Between the pyramids are found the columns of Bertini; these are processes from the cortex and contain blood vessels, lymphatics and nerves.

At the bases of the pyramids in the cortex, are seen the medullary rays which are made up of the cortical portions of the straight collecting tubules, the descending and ascending limb of Henle and blood vessels. The areas of cortex between these rays are known as the labyrinth. The pyramids of Ferrein are seen at the periphery of the cortex and lie external to the medullary rays and labyrinth.

The kidney substance is made up of small tubules, which consist of a basement membrane lined with epithelium and separated one from the other by connective tissue. The tubules begin as blind dilated extremities in the labyrinths and form what is called the capsule. This is surrounded by looped capillary blood vessels, which in turn are covered by a thin reflected layer of the capsule. The capillaries are thus inclosed between the two layers and the whole is

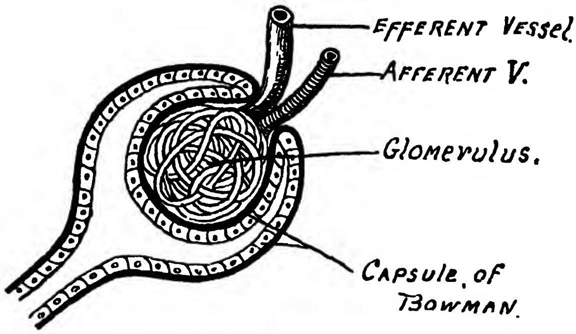


FIG. 33.—MALPIGHIAN CORPUSCLE.

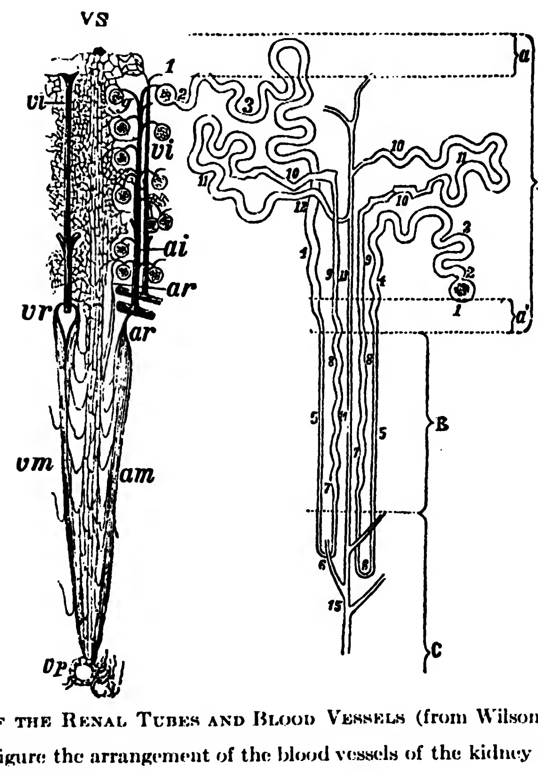


FIG. 34.—SCHEME OF THE RENAL TUBES AND BLOOD VESSELS (from Wilson: modified from Klein).

On the left of the figure the arrangement of the blood vessels of the kidney is shown, on the right the course of the uriniferous tubules.

v.s, venæ stellatæ of Verheyen.
v.i, interlobular veins.
v.r, venæ rectæ.
v.m, veins of medullary part.
v.p, veins of papillæ.
a.i, interlobular artery.
g, glomerulus.
a.r, arteriæ rectæ.
a.m, arteries of medullary part.

A, cortex.
B, boundary zone.
C, papillary zone of medulla.
a.a', superficial and deep layers of cortex, free of glomeruli.
1, Malpighian capsule.
2, neck.
3, first convoluted tubule.
4, spiral tubule of Schachowa.

5, descending limb of looped tubule of Henle.
6, bend.
7, *8*, *9*, ascending limb.
10, irregular tubule.
11, second convoluted tubule.
12, junctional tubule.
13, *14*, collecting tubule.
15, excretory tubule.

called a Malpighian corpuscle (Fig. 33). The first part of the tubule leading from the capsule is the first convoluted tubule; it passes through the labyrinth to the medullary ray and becomes the spiral tubule. Thence it passes into the intermediate zone, then straight through the pyramid toward the apex. This part is known as the descending limb of Henle's loop. Near the apex it bends around, forming the loop of Henle, and passes upward through the pyramids, through the intermediate zone into the medullary ray, as the ascending limb of Henle's loop. It now continues its course to the labyrinth as the irregular tubule, becoming more uniform within the labyrinth; this portion is known as the second convoluted tubule. This ends in the junctional tubule which, passing into the medullary ray, joins the collecting tubule. The collecting tubule is made up of several renal tubules and pursues a straight course to the apex of the pyramid. Here several unite to form one excretory duct, which opens at the renal papillæ in the kidney sinus (Fig. 34).

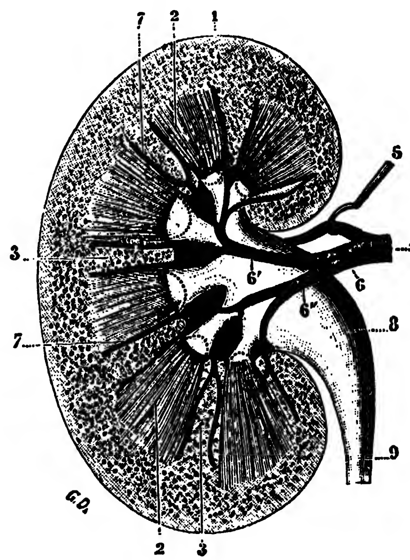


Fig. 35.—The Renal Artery and Its Branches. (Testut.)

Right kidney. Sagittal section seen from the front.

1, capsule.
2, pyramids of Malpighi.
3, *3*, columns of Bertini.
4, renal artery.
5, its posterior branch.
6, its anterior branch bifurcating.
7, peripyramidal arteries.
8, renal pelvis.
9, ureter.

Blood Supply.—The kidney is supplied with blood by the renal artery. The chief function of this artery, however, is not to nourish the gland but to allow the various products of metabolism in the systemic circulation to be acted upon by the kidney.

The Renal Artery.—In the sinus, the artery subdivides into a fan-shaped plexus, as seen in Fig. 29, and the terminal branches enter the projections produced by the columns of Bertini (Fig. 35). On entering these, at their centers, the arteries at once bifurcate, so that each division skirts the boundary of a pyramid. Each pyramid is supplied with four or five arteries which travel along its surface until the base is reached (lobar or peripyramidal arteries). At the bases, they give transverse arched branches which anastomose with similar branches from other lobar arteries, and form the suprapyramidal arch or plexus. The meshes of this network surround the base of a pyramid transversely like a collar. From this network arise a number of arteries directed toward the fibrous capsule, usually between two pyramids of Ferrein (Fig. 36).

These arterioles, known as the interlobular vessels, end in the capsule in "capsular branches," some of which perforate into the perirenal fat. The interlobular vessels, however, give off lateral branches all along their route through the parenchyma, which end in the afferent vessels of numerous Malpighian tufts.

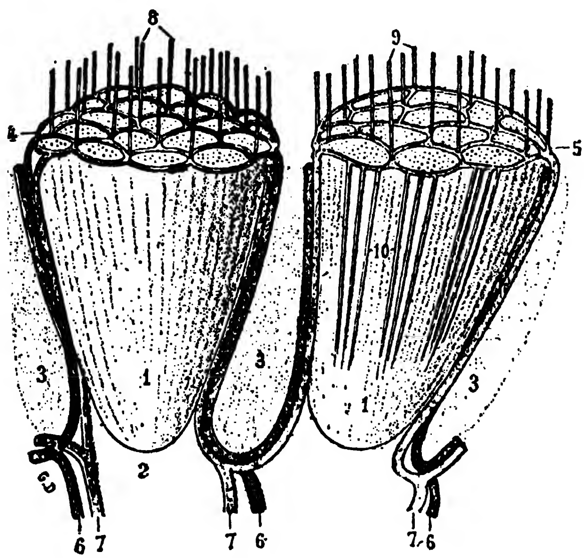


Fig. 36.—Schematic Drawing Showing the Theory of the Arrangement of the Vascular Arches over the Pyramids. (Testut.)

1, *1*, two Malpighian pyramids.
2, sinus of the kidney.
3, columns of Bertini.
4, arterial arches.
5, venous arches.
6, branches of the renal artery.
7, branches of the renal vein.
8, interlobular arteries.
9, interlobular veins.
10, direct (straight) veins.

The glomerular capillaries are twisted around each other, forming the lobulated tuft described above, and end in an efferent arterial capillary.

Leaving the glomeruli, the efferent capillaries pass toward the convoluted tubules and the pyramids of Ferrein, and form a network which surrounds and supplies all the cortical tubules. In the medulla, the straight tubules are found accompanied by parallel capillaries—the arteriæ rectæ —which are probably also derived from the efferent capillaries of the glomerulus. The arteriæ rectæ form a rectangular network about the papillary orifice of the collecting tubule.

Abnormalities of the Kidneys.—(1) Complete absence of one kidney.

(2) One kidney very small and atrophied, the other hypertrophied and very large.

(3) Lobulation, such as is seen in the fœtus and in some of the lower animals.

(4) Horseshoe kidney, the two kidneys being fused together at the lower pole.

(5) Abnormal position, one kidney, usually the left, may be placed very low, opposite the sacro-iliac synchondrosis, this being the location of its early origin.

(6) More than one renal artery may be present, or the main artery may break up before it enters the sinus.

THE URETER

The ureter is a fibro-muscular canal, which conducts the urine from the kidney to the bladder. When in situ it measures about fifteen inches (37 cm.) (Fig. 37).

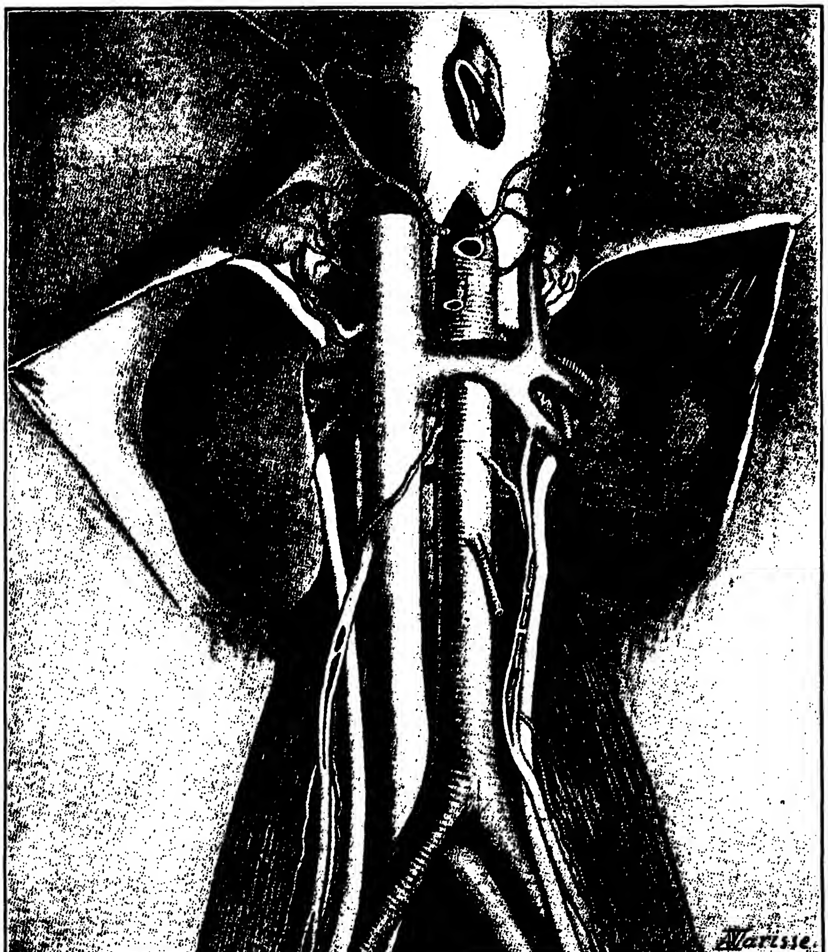


FIG. 37.—SHOWING THE RELATIONS OF THE URETER TO THE INFERIOR POLE OF THE KIDNEY AND TO THE BLOOD VESSELS OF THIS REGION. (Hartmann.)

On both sides, it lies on the psoas muscle behind the peritoneum (Fig. 38), and is crossed obliquely by ovarian or spermatic vessels. The genito-crural nerve passes behind it on both sides, in a direction from within downward and outward. On the right side, the duodenum lies in front of its commencement. Lower down it is crossed by the ileo-colic artery and the root of the mesentery. On the left side, the left colic artery and the mesentery of the pelvic colon pass in front.

Crossing the pelvic brim at the bifurcation of the common iliac or at the commencement of the external iliac (Fig. 39), it passes down from the side wall of the pelvis in a curved direction, the convexity of the curve being backward. It passes over the obturator nerve and artery and obliterated hypogastric artery, as they run forward on the side wall of the pelvis. At the spine of the ischium, it crosses inward over the floor of the pelvis and is crossed by the vas deferens near its termination. As it enters the bladder, it lies in front of the vesiculæ seminales and is surrounded by veins continuous with the vesical and prostatic plexus. As they enter the bladder, the two ureters are

FIG. 38.—A SAGITTAL SECTION OF THE PELVIS TO THE LEFT OF THE MEDIAN LINE. (After Hartmann.)

On the right the peritoneum is seen intact with the ureter outside of it, whereas on the left the extra peritoneal tissue and the common iliac branching into the external and internal iliac branches are seen. If the two sides were brought together the ureter would occupy the space at the bifurcation of the common iliac.

placed about two inches (5 cm.) apart. They run from the bladder wall in an inward direction for three quarters of an inch (1.87 cm.) (Fig. 40), and open on the internal surface by two valvular slitlike orifices which in the empty bladder are about one inch (2.5 cm.) apart. In the female, the pelvic portion of the ureter has somewhat different relations. As it runs down on the side wall of the pelvis, it produces a ridge in the peritoneum, which forms the posterior boundary of a small fossa (fossa ovarica) in which the ovary lies. The upper and anterior boundary of this fossa are formed by the external iliac. It then passes inward underneath the broad ligament, passing over the vault of

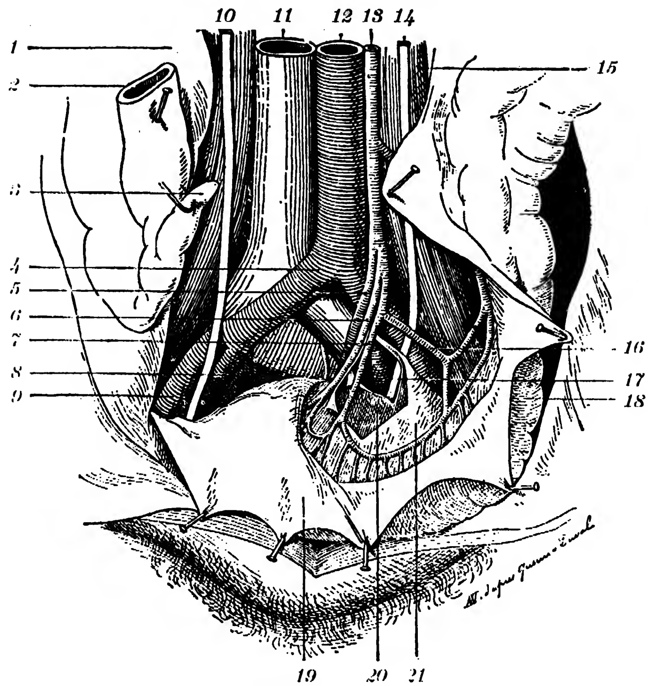


FIG. 39.—THE RELATIONS OF THE URETER TO THE PELVIC TISSUES. (After Duval.)

The ureter is seen to pass just below the bifurcation of the common iliac.

1, ascending colon.
2, end of ileum held up.
3, appendix held up.
4, common iliac.
5, superior hemorrhoidal.
6, right sigmoidal.
7, middle sigmoidal.
8, internal iliac.
9, external iliac.
10, right ureter.
11, vena cava.
12, aorta.
13, inferior mesenteric artery.
14, left ureter.
15, psoas muscle.
16, left sigmoidal artery.
17, internal iliac.
18, colon.
19, anterior layer of pelvic mesocolon.
20, posterior layer of peritoneum.
21, posterior layer of pelvic mesocolon.

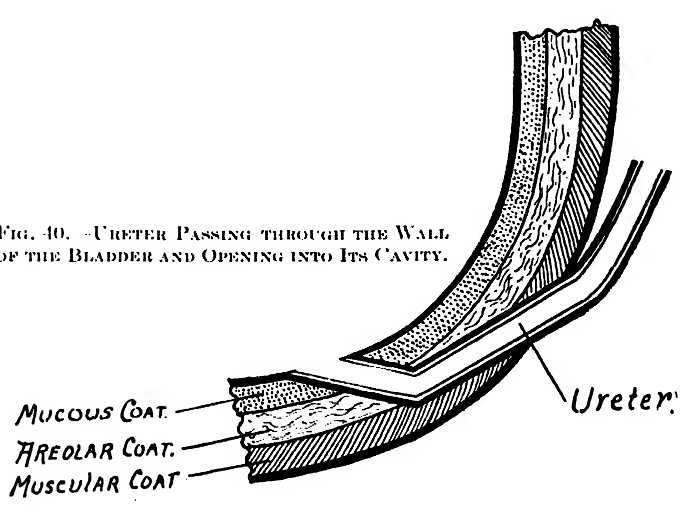


FIG. 40.—URETER PASSING THROUGH THE WALL OF THE BLADDER AND OPENING INTO ITS CAVITY.

the lateral fornix of the vagina about a quarter of an inch (0.6 cm.) from the lateral border of the cervix uteri. Near its termination it is crossed by the uterine artery (Fig. 41). Its course within the bladder is the same as in the male.

Structure.—The wall is composed of an outer fibrous layer, then a middle muscular layer, the muscular coat being in three strata.

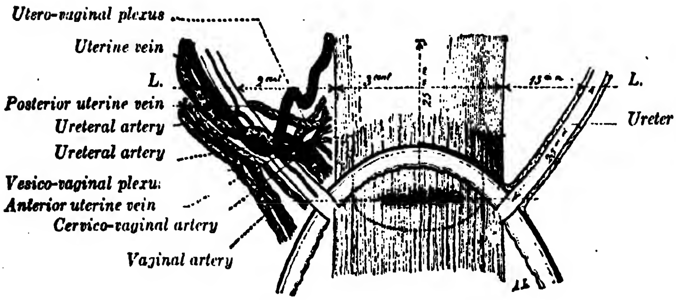


FIG. 41.—SCHEMATIC DRAWING OF THE RELATIONS OF THE URETER TO THE NECK OF THE UTERUS AND ITS VESSELS. (Poirier.)

L.L. is a line drawn just below the uterine isthmus. The striations below this represent the vaginal wall. The outline of the cervix uteri is indicated in this area by a dotted line. An arch in front of the cervix and vagina represents the outline of the bladder wall through the sides of which the ureters are seen to extend. On the right side of the cervix about the ureter, the uterine and vaginal arteries and veins are seen. The uterine artery and vein pass in front of the ureter.

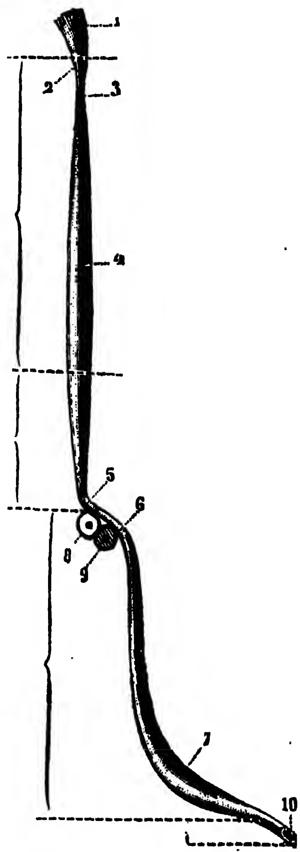


FIG. 42.—SHAPE OF THE RIGHT URETER AFTER IT HAS BEEN INJECTED WITH TALLOW. (Testut.)

1, pelvis of kidney.
2, infundibulum.
3, narrowing.
4, wide or abdominal portion.
5, bend at pelvic brim.
6, narrowing at brim.
7, widening in pelvic portion.
8, *9*, external iliac artery and vein.
10, vesical orifice.

The middle fibers are circular, the outer and inner longitudinal. Inside of the muscular coat is the mucous membrane, the epithelium of which is the same as that found in the bladder.

Caliber of the Ureter.—The caliber of the ureter is not uniform throughout its extent. At its junction with the pelvis, its diameter is about 3.2 mm. From this point on it gradually dilates until it reaches a diameter of 8 mm. As it passes from the abdomen into the pelvis, its diameter is about 4 mm. From that point to its termination there is a slight gradual decrease in its caliber (Fig. 42).

Variations.—The ureter is sometimes double at its commencement; sometimes it is double throughout its course. In rare cases, one ureter may open into the vagina or urethra.

THE BLADDER

The bladder is a muscular pouch which acts as a temporary reservoir for the urine. Its capacity varies in different individuals, but an average is about twelve ounces. It is situated in the anterior part of the pelvic cavity, behind the symphysis pubis and the retro-pubic pad of fat, and in front of the rectum, from which, in the male, it is separated by the vesiculæ seminales and the terminal portion of the vas deferens. In the female, it is separated from the rec-

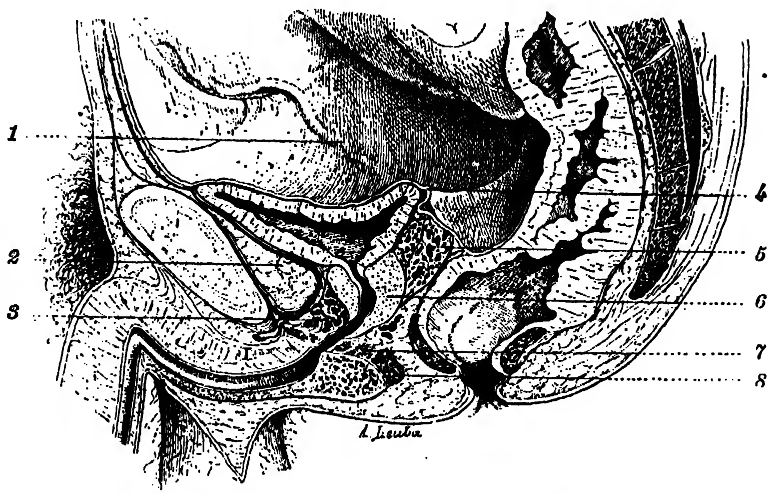


FIG. 43.—BLADDER BUT SLIGHTLY DILATED ON SAGITTAL SECTION, SHOWING ITS APEX AND BASE. (Poirier.)

1, vas deferens.
2, Retzius space.
3, plexus of Santorini.
4, retro-vesical fold.
5, seminal vesicle.
6, prostate.
7, transverse deep perineal muscle.
8, transverse superficial perineal muscle.

tum by the uterus and upper part of the vagina (Fig. 47). It presents varying forms and relations according to whether it is distended or empty.

Relations.—The bladder has an apex and five surfaces; they are a superior or abdominal, a postero-inferior or basal, antero-inferior or pubic and two lateral (Figs. 43 and 44).

The apex looks upward and forward and is connected to the abdominal wall by a fibro-muscular cord, the urachus. On either side of it are the obliterated hypogastric arteries which pass upward from the sides of the bladder.

The superior or abdominal surface is entirely covered by peritoneum and extends antero-posteriorly from the apex to the base. Laterally it is separated from the sides of the bladder by the obliterated hypogastric arteries (Fig. 45).

The antero-inferior or pubic surface (Figs. 46 and 47) is that part of the bladder in relation with the symphysis pubis, the triangular ligament, internal obturator muscles and the anterior portions of the levator ani. It looks downward and forward, and is not covered by peritoneum.

The base or fundus (diagrammatic view) looks downward and backward (Fig. 48). In the male, it is in relation to the rectum, from which it is separated by a reflection of the recto-vesical fascia. In the female, the base lies in contact with the upper part of the anterior wall of the vagina and the cervix of the uterus.

The lateral surfaces or sides (Fig. 48) are in relation to the levator ani and obturator internus muscles with their fascial coverings. The sides are

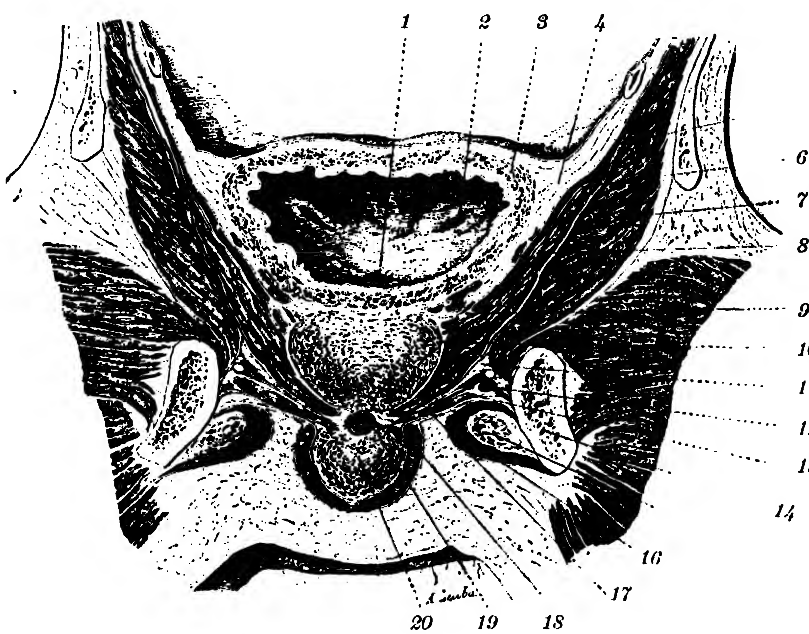


FIG. 44.—VERTICAL TRANSVERSE SECTION OF PELVIS JUST IN FRONT OF THE INTERNAL MEATUS SHOWING THE TRIGONE AND THE URETHRAL ORIFICES. (Poirier.)

1, neck of bladder.
2, ureteral orifice.
3, bladder.
4, lateral ligament.
5, obturator fascia.
6, levator ani fascia.
7, obturator intrenus muscle.
8, levator ani muscle.
9, pelvic layer of fascia.
10, lateral prostatic fascia (capsule).
11, extension of ischio-rectal foss.
12, internal pubic artery.
13, deep transverse perinei muscle.
14, ischio-pubic ramus.
15, corpus cavernosum.
16, ischio-cavernosus muscle.
17, bulbo cavernosus artery.
18, bulbo cavernosus muscle.
19, membranous urethra.
20, bulb of the urethra.

crossed obliquely from below, upward and forward, by the obliterated hypogastric artery. Above and behind this cord, the bladder is covered by peritoneum, while below and in front, it is covered by recto-vesical fascia.

That portion of the bladder immediately around the internal urethral orifice is called the "neck." In the male, it rests upon the prostate and connects with the urethra passing through it, but has no definite anatomical limits.

The Distended Bladder.—When the bladder is distended, the various borders and surfaces are obliterated so that the bladder assumes an oval shape (Fig. 49). The superior surface, upper part of the infralateral and upper part of the basal surfaces, take most part in the distention, and the lateral and posterior borders are obliterated. The superior surface, from being almost a flat plane, assumes varying degrees of convexity until it comes to represent a segment of a sphere (Fig. 49). The peritoneal reflection from the apex is carried upward with increasing distention until it may be from one to two inches (2½ to 5 c.c.) above the symphysis, thus markedly increasing the area of the prevesical space, or space of Retzius. Laterally, the peritoneal reflection from the side wall of the pelvis is also elevated. Behind, its alteration in position is very slight, but the recto-vesical space is relatively increased. In depth, the urethral orifice and lower part of the bladder remain fairly constant in position, the orifice descending slightly. The distended bladder comes into more intimate relation with the side wall of the pelvis, being in apposition with the hypogastric artery, the obturator vessels and nerves, and the vas deferens; while a large part of the organ becomes

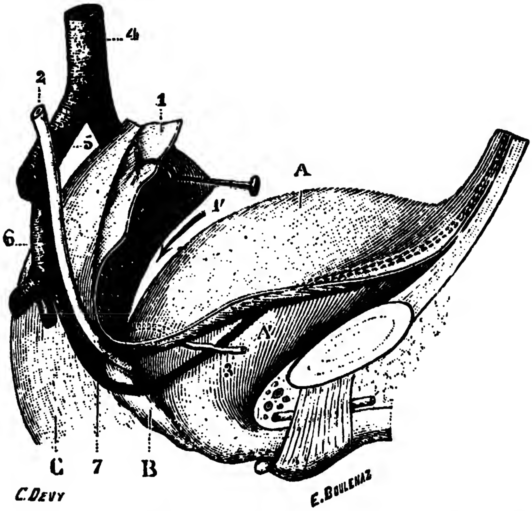


FIG. 45.—THE PERITONEAL REFLECTION ON THE SIDE OF THE BLADDER ALONG THE COURSE OF THE HYPOGASTRIC ARTERY, AS SEEN IN THE NEWBORN. (Testut.)

This artery in the adult is obliterated in the greater part of its course, forming a cord.

A, superior posterior part of the bladder covered by peritoneum.
A', inferior anterior part of the bladder not covered by peritoneum.
B, seminal vesicle.
C, rectum.
1, vesico-rectal peritoneum forming cul-de-sac.
2, right ureter.
3, right vas deferens.
4, aorta.
5, right iliac artery.
6, right internal iliac.
7, right umbilical.

N. B.—The umbilical artery forms most of the obliterated portion of what is generally spoken of as the hypogastric artery. It comes from the internal iliac.

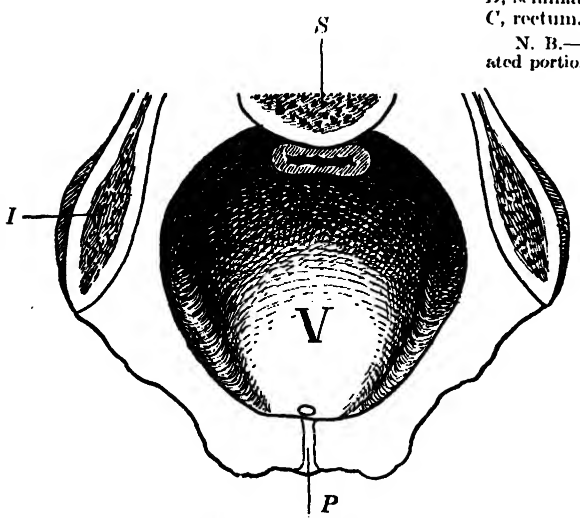


FIG. 46.—DIAGRAMMATIC DRAWING SHOWING THE UPPER SURFACE OF THE BLADDER IN THE MALE AS SEEN FROM ABOVE WHEN LOOKING DOWN INTO THE PELVIS.

V, upper surface of bladder.
P, symphysis pubis.
S, sacrum.
I, ileum.

intra-abdominal and is in relation to the anterior abdominal wall for a varying distance.

Ligaments of the Bladder.—The ligaments are described as true and false. The false ligaments are merely folds of peritoneum. A reflection of peritoneum from the apex over the urachus is called the anterior false ligament. This forms the upper part of the posterior wall of the space of Retzius. The peritoneal reflection from the side wall of the pelvis to the lateral borders and superior surface of the bladder are the lateral false ligaments. They dip down slightly into the space between the bladder and pelvic walls, which is called the

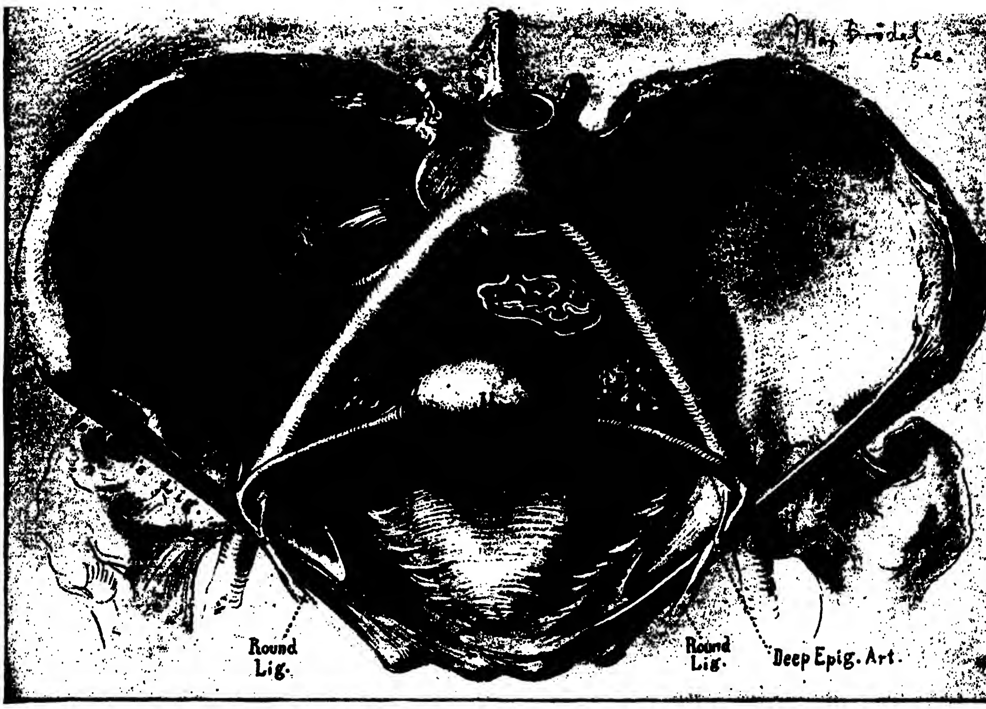


FIG. 47.—THE UPPER SURFACE OF THE BLADDER IN THE FEMALE TOGETHER WITH THE OTHER PELVIC ORGANS AS SEEN FROM ABOVE. (Kelly.)

paravesical fossa. Behind, two distinct folds of peritoneum cover the vas deferens and are described as posterior false ligaments; these correspond to the folds of Douglas in the female, and form the lateral boundaries of the recto-vesical pouch.

The true ligaments consist of the urachus extending from the apex to the anterior abdominal wall; the lateral processes of pelvic fascia firmly fix the lower part of the bladder in position. In front, two folds of this fascia extend from the symphysis over the prostate to the inferior surface of the bladder—the pubo-prostatic ligaments. Within these folds are strands of muscular fibers. The lateral ligaments are the pelvic fascia as it passes from the levator ani to

the bladder. The basal surface is fixed in its lower part by the fascia surrounding the vesiculæ seminales and termination of the vas deferens. This

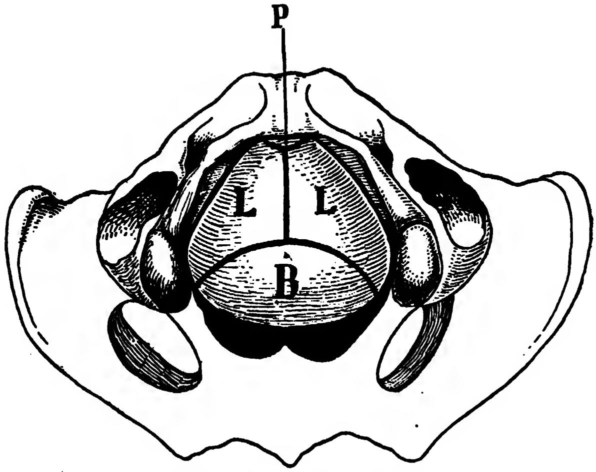


FIG. 48.—DIAGRAMMATIC DRAWING SHOWING THE BASE AND SIDES OF A DILATED BLADDER IN A PELVIS FROM WHICH THE FLOOR AND THE TISSUES CONSTITUTING THE PERINEUM HAVE BEEN REMOVED.

The lower part of the anterior surface is just seen. The pelvis is in the lithotomy position.

P, antero-inferior or pubic surface.
L, lateral surfaces.
B, base.

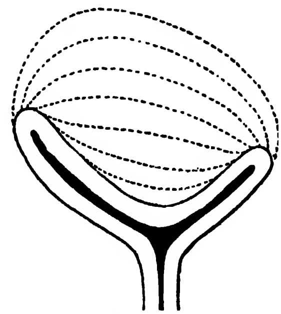


FIG. 49.—CHANGE IN THE SHAPE OF THE BLADDER WHILE FILLING. (Poirier.)

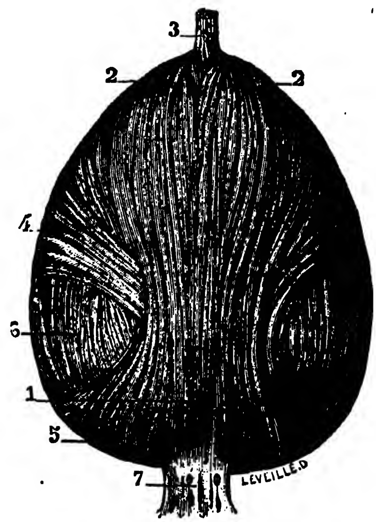


FIG. 50.—LONGITUDINAL MUSCULAR FIBERS OF THE ANTERIOR LAYER OF THE BLADDER WALL. (Sappey.)

1, longitudinal fibers of the anterior wall.
2, *2*, the same fibers which are continuous at the top of the bladder with those of the opposite side.
3, the urachus surrounded by the middle anterior fibers.
4, group of fibers detaching themselves from the principal bundle to spread over the lateral vesical wall.
5, lateral fibers extending out from the longitudinal.
6, antero-lateral longitudinal fibers.
7, aponeurosis by which the longitudinal medium fibers attach themselves to the inferior part of the symphysis pubis.

contains some muscular fiber and extends backward, gaining attachment to the rectum and the front of the sacrum.

Structure of the Bladder.—The serous or peritoneal coat, as we have seen, only gives a partial covering to the viscus. The muscular coat is very thick and is disposed in three layers, which are somewhat irregular. The outer coat is disposed for the most part in a longitudinal or vertical direction, some of the fibers from the inferior surface being continuous with the musculature of the prostate, while in front they are continuous with the muscle fibers in the puboprostatic ligament (Fig. 50). The middle coat is not found as a complete layer, some of the fibers being horizontal (Fig. 51) and some longitudinal. Over the trigone it forms a continuous layer, the fibers running transversely, while near the urethral orifice they are dispersed in a cir-

cular manner. The inner coat is a thin stratum, the fibers of which run longitudinally, forming the internal sphincter (Fig. 52). The submucous coat separates the mucous membrane from the inner muscular layer. This forms a definite layer, except over the trigone of the bladder, where the mucous layer is firmly adherent to the underlying muscular surface.

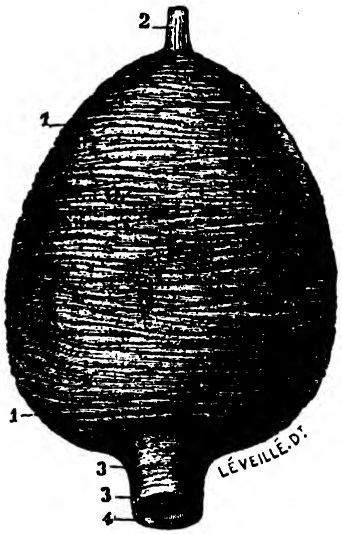


FIG. 51.—MIDDLE OR CIRCULAR LAYER OF THE MUSCULAR WALL OF THE BLADDER. (Sappey.)

1, 1, circular or transverse fibers of the bladder forming bundles which fit into one another.
2, muscular fibers of the urachus.
3, 3, sphincter of the bladder embracing the beginning the prostatic portion of the urethra.
4, cut through the vesical sphincter showing its thickness.

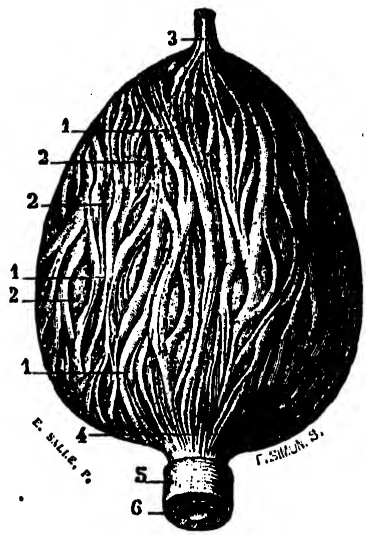


FIG. 52.—DEEP LAYER OF THE BLADDER WALL. (Sappey.)

1, 1, 1, streaked bundles of fibers extending from the top toward the neck of the bladder dividing and uniting with one another.
2, 2, 2, elliptical meshes in the longitudinal axis resulting from the union of these bundles.
3, muscular fibers at the urachus separating below and continuous with the other fibers.
4, fibers of this layer forming a cylindrical sheath which extends along the urethral mucosa.
5, sphincter of the bladder.
6, cut section of the prostatic portion of the urethra.

The mucous layer is a continuous membrane lining the whole internal surface of the bladder, and is continuous with that of the ureters and urethra; it is disposed in folds and is loosely attached to the bladder wall, except over the region of the trigone. The epithelium is a transitional stratified type, the same as that lining the ureter.

Cavity of the Bladder.—In the empty bladder, this is said to assume the shape of the letter "Y" (Fig. 43). The stem of the Y is represented by the beginning of the prostatic urethra in the male. Normally in the living body, the interior of the bladder probably never possesses this shape, but would be better represented as a slitlike cavity extending from the apex almost directly

backward to the internal meatus. In the distended bladder, the cavity assumes an oval shape (Fig. 49).

The Orifices.—On the inner surface, three openings may be seen: Above and behind, the two openings of the ureters, while at the lowest part is the urethral internal meatus or urethral orifice (Fig. 44). Lines joining these orifices would form the boundaries of an equilateral triangle, the sides measuring about an inch (2.5 c.c.) in the empty bladder. This triangular area is called the trigone.

Vessels and Nerves.—The *blood supply* of the bladder comes from the superior and inferior vesical arteries. The veins (Figs. 53 and 54) form a dense

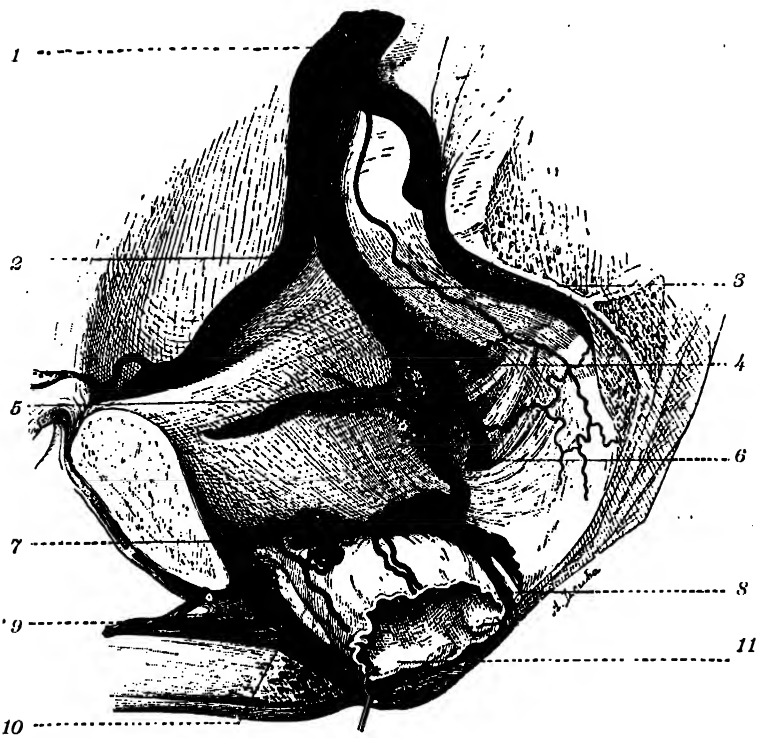


Fig. 53.—Veins in the Male Pelvis after the Rectum has Been Removed and the Bladder Pulled Down. (Henle.)

1, vena cava.
2, external iliac.
3, internal iliac.
4, gluteal.
5, obturator.
6, sciatic.
7, plexus of Santorini.
8, vas deferens.
9, dorsalis penis.
10, internal pubic.
11, bladder.

plexus about the base of the bladder just above the prostate and surrounding the entrance of the ureter. This plexus communicates freely with the prostatic plexus and empties into tributaries of the internal iliac veins. The lymphatics go to the iliac glands.

The *nerve supply* is derived from the pelvic plexus of the sympathetic and the third and fourth sacral nerves. The former supplies the upper portion and the latter its neck and base.

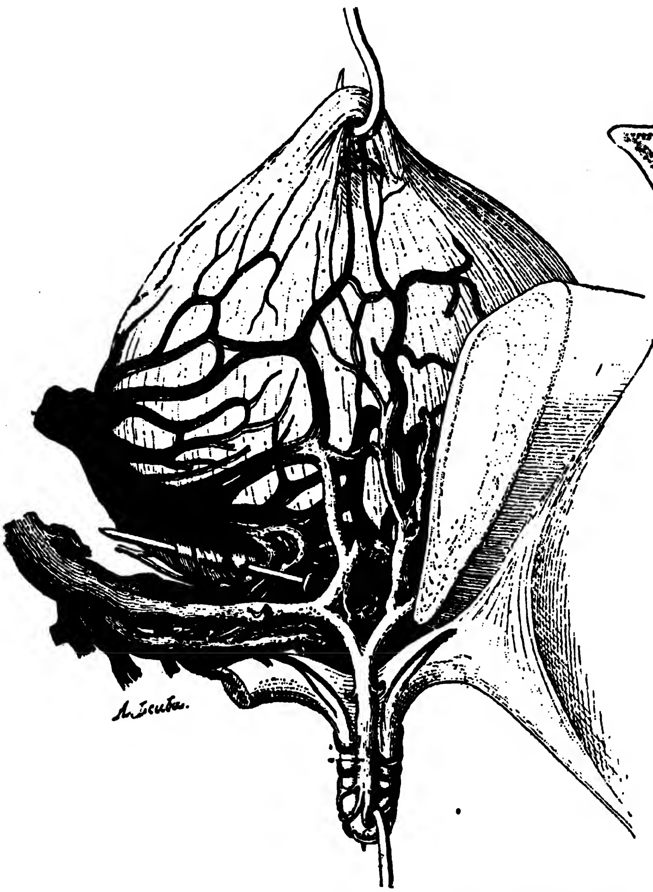


FIG. 54.—VEINS ABOUT A FEMALE BLADDER AS SEEN FROM THE FRONT. (Poirier.)

They empty into the internal iliac principally through the vesical and internal pudic vein.

FIG. 55.—ENTIRE LENGTH OF THE MALE URETHRA FROM THE NECK OF THE BLADDER TO THE EXTERNAL URINARY MEATUS. (Taylor.)

THE URETHRA

The male urethra is a canal extending from the bladder to the external meatus. In the male it measures about eight inches in length, and passes through the prostate, compressor urethræ muscle and corpus spongiosum of the penis (Fig. 55). In its course from the bladder as far as the suspensory ligament, the urethra forms a continuous curve with the convexity backward. At this point a reverse curve appears when the penis is flaccid. The whole course

of the canal thus resembles the letter "S" (Fig. 56). When the penis is erect or held in position for the passage of an instrument, the reverse curve is

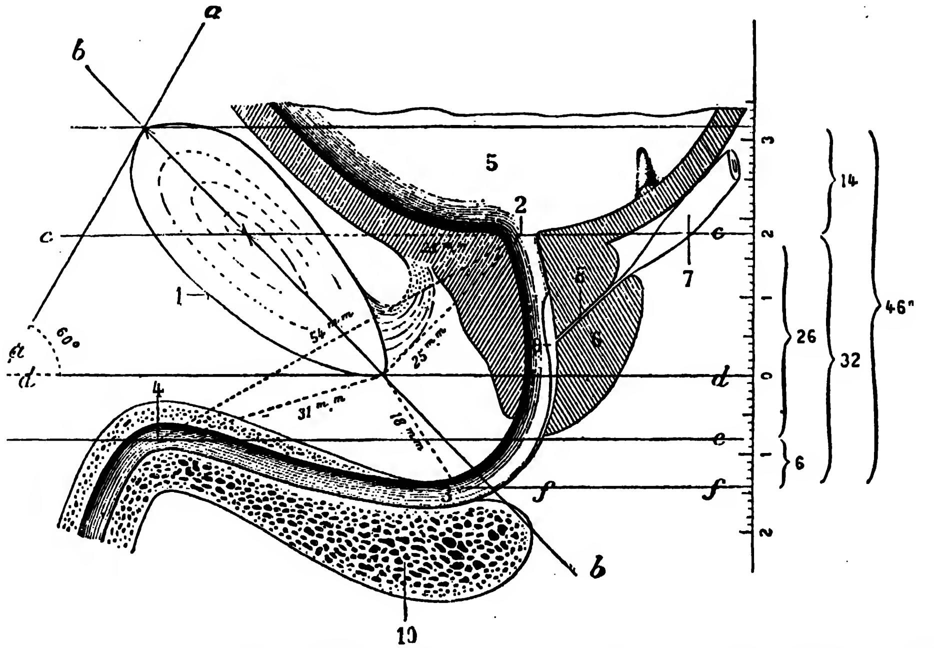


Fig. 56.—Curves of the Urethra When the Organ is Flaccid, also the Fixed Portion of the Canal. (Testut.)

1, symphysis pubis.
2, neck of bladder.
3, lowest point of the bulb of the urethra.
4, angle of the penis.
5, bladder cavity.
6, prostate.
7, vas deferens.
8, ejaculatory duct.
9, veru montanum.
10, bulb of urethra.
a, *a*, the plane of the superior strait of the pelvis.
b, *b*, axis of the symphysis.
c, *c*, horizontal line drawn through the neck of the bladder.
d, *d*, horizontal line passing through the lowest edge of the symphysis.
e, *e*, horizontal line drawn through the penile angle.
f, *f*, horizontal line drawn through lowest part of the membranous canal.

On the right of the figure is to be found a scale in the metric system which permits the reader to make out rapidly the distance in a vertical line which separates different parts marked on the cuts.

obliterated, the anterior limb of the posterior curve being prolonged forward and upward (Fig. 57).

The urethra is divided into three portions for descriptive purposes: the prostatic, the membranous and the spongy portion.

The Prostatic Urethra.—This part extends

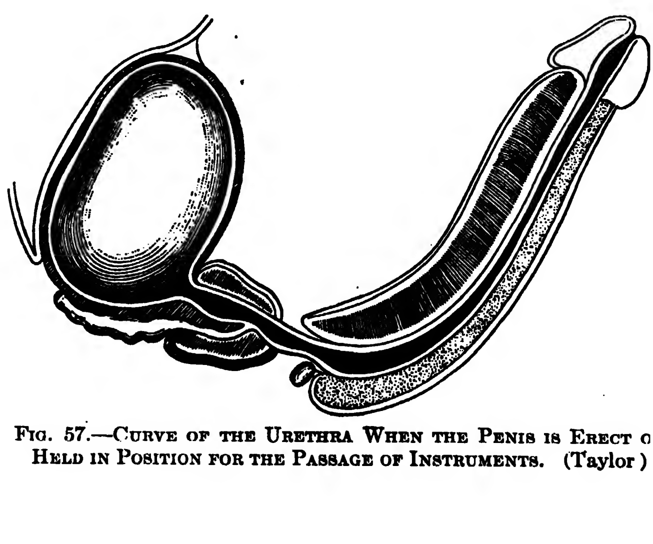


Fig. 57.—Curve of the Urethra When the Penis is Erect o Held in Position for the Passage of Instruments. (Taylor)

through the prostate gland, and is slightly curved in direction, the convexity of the curve being backward (Fig. 58). It is one and one quarter inches (3.1 cm.) in length, and is somewhat spindle-shaped. The dilated middle portion is the widest part of the whole urethra. On cross section it is hors shoe-shaped, with the co vexity forward. Th posterior wall or floor contains a median ridge the veru montanum, on the summit of which is a small depression. This depression is the opening of the sinus pocularis, a small cul-de-sac which extends into the prostate for about one quarter of an inch, and is analogous in the male with the uterus in the female. On either side of its opening into the urethra, are the openings of the common ejaculatory ducts. About the veru montanum, are the openings of the ducts of the prostate, while on either side is a groove called the prostatic sinus.

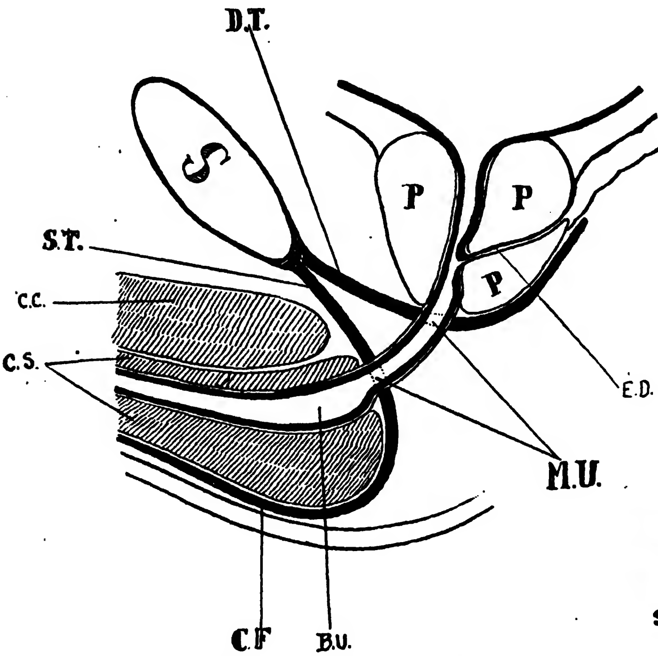


Fig. 58.—Membranous Urethra and Its Relation to the Triangular Ligament.

M.U, limits of membranous urethra.
D.T, deep layer triangular ligament.
S.T, superficial layer of triangular ligament.
c.c, corpus cavernosum.
C.S, corpus spongiosum.
C.F, Colles' fascia.
B.U, bulbous urethra.
P, prostate.
E.D, ejaculatory duct.
S, symphysis

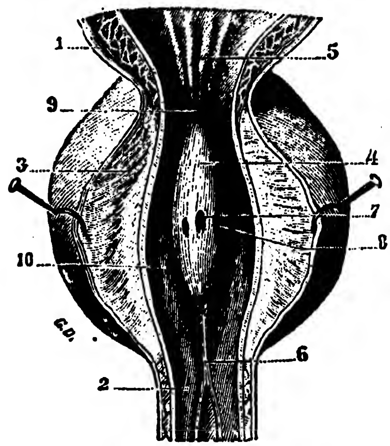


Fig. 59.—Genito-urinary Sinus in the Male, the Prostate Having Been Opened Anteriorly and Its Lateral Lobes Retracted. (Testut.)

At this point, the posterior urethra is seen in direct communication with the bladder and with the ejaculatory ducts.

1, the bladder.
2, urethra.
3, prostate.
4, veru montanum.
5, frenum of the veru montanum.
6, urethral crest.
7, prostatic utricle (sinus pocularis).
8, orifices of the ejaculatory ducts.
9, prostatic fossette.
10, lateral depressions of the veru montanum.

The Membranous Portion.—This part extends from the prostate to the bulb of the

penis. It is about an inch (2.5 cm.) from the symphysis pubis, and lies between the two layers of the triangular ligament. The anterior wall is about one half inch in length, while the posterior wall is a little more. This is due to the fact that the urethra opens into the bulb by an oblique opening. It is completely surrounded by the compressor urethræ muscles, while on either side are Cowper's glands. At its commencement, it is immediately in front of the rectum, but in its course it curves forward while the rectum curves backward; hence at its termination there is an interval of about half an inch between the two. At its termination the anterior portion has passed through the triangular ligament before entering the bulb, and here there is a small area with no immediate covering and it can be easily punctured by an instrument (Fig. 58).

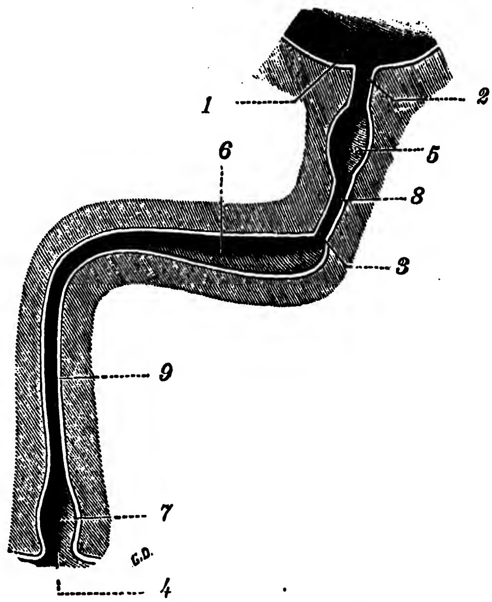


FIG. 60.—THE NATURAL DILATATIONS AND NARROWINGS OF THE URETHRA. (Testut.)

1, the bladder.
2, neck of bladder.
3, collar of the bulb.
4, meatus.
The natural dilatations are:
5, of the prostate.
6, of the bulb.
7, of the fossa navicularis.
The narrowings are:
8, of the membranous urethra.
9, of the penile portion.

The Spongy Portion.—The spongy portion extends from the anterior layer of the triangular ligament to the meatus and is about six inches (15 cm.) in length. It is surrounded by the erectile tissues of the corpus spongiosum, the greater part of the tissue being behind the urethra in the bulb, and in front and on the side of the glans. The caliber of this part is not uniform throughout (Fig. 60), thus it is larger in the part surrounded by the bulb, becomes smaller in the corpus spongiosum, and as it enters the glans it becomes markedly dilated, the dilated portion being known as the fossa navicularis. The external meatus is vertical in direction, and is the narrowest and least dilatable portion of the whole canal. Therefore, it will be seen in Fig. 60 that the three dilatations of the canal are the fossa navicularis, the bulb and the prostate.

The Structure.—The urethra consists of a muscular, submucous and mucous layer. The external coat is a thin layer of unstriped muscle, continuous with the musculature of the bladder and prostate. The submucous layer consists

of vascular and erectile tissue. This is found not only in the spongy portion but also in the membranous and prostatic portions. The mucous membrane is a thin delicate layer lined by transitional epithelia continuous with the bladder and urethra. The superficial epithelium of the mucous membrane is columnar, except at the meatus and fossa navicularis, where it becomes squamous. The membrane is disposed in folds during the flaccid condition of the organ, and on the internal surface are the orifices of numerous glands. Some of these in the membranous and the first part of the spongy portion are called the glands of Littre. The ducts of Cowper's glands open into the bulbous portion near its commencement.

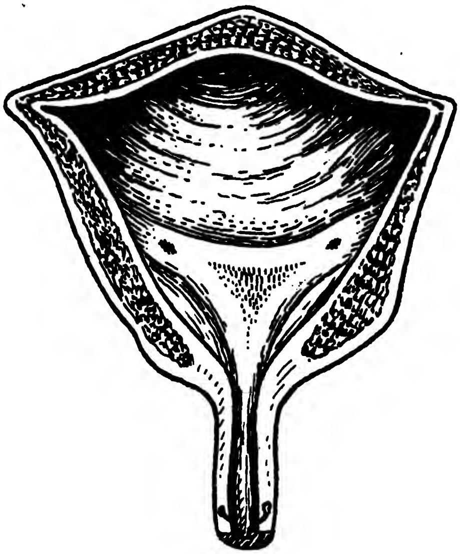


FIG. 61.—TRANSVERSE VERTICAL SECTION THROUGH THE FEMALE URETHRA.

Skene's glands are near its end. Compare it with Fig. 55, the male urethra.

The urethra in the female (Fig. 61) is a short canal about one and one half inches (3.7 cm.) in length, imbedded in the anterior vaginal wall. The external meatus is situated beneath the clitoris and has the shape of an inverted "V." The whole urethra in the female morphologically represents that portion of the prostatic urethra in the male which is situated between the bladder orifice and the sinus pocularis.

The Blood Supply.—The prostatic portion is supplied by branches of the middle hemorrhoidal artery, the membranous portion by the inferior hemorrhoidal and transverse perineal arteries, the spongy portion by the arteries which go to the penis. The venous return is in part by the dorsal vein of the penis, and in part directly by the prostatic plexus. The lymphatics of the membranous and spongy portion go to the inguinal glands, while those of the prostatic portion go to the iliac glands.

The nerve supply of the urethra is from the superficial perineal and dorsal nerves of the penis, and also branches from the hypogastric plexus.

COWPER'S GLANDS

These are two small bodies about the size of a pea, placed on either side of the membranous urethra, between the apex of the prostate and the bulb of the corpus spongiosum (Fig. 62). The gland consists of numerous branching tubules, which are arranged in small lobules. The excretory duct

of each gland passes forward between the urethra and the substance of the bulb for about an inch (2.5 cm.), opening by a minute orifice on the floor of the urethra. The glands of Bartholin, in the female, are the analogues of the glands of Cowper in the male. They are slightly larger than the latter glands, and open outside of and external to the hymen just beneath the labia minora.

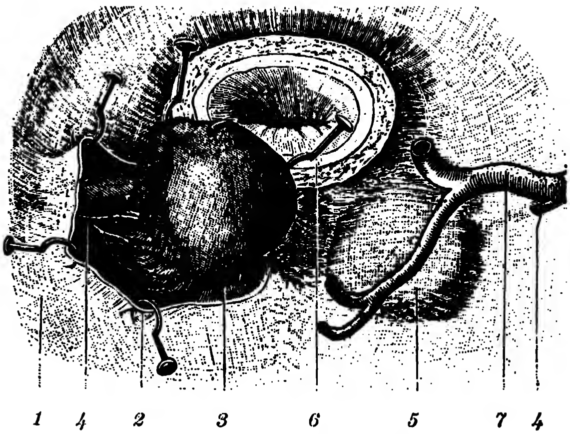


FIG. 62.—COWPER'S GLANDS.
(After Testut and Jacob.)

1, anterior layer of the deep perineal fascia (triangular ligament).
2, the fascia incised and drawn down.
3, Cowper's gland on the right side freed and delivered.
4, artery of Cowper's gland.
5, Cowper's gland on the left side covered by fascia.
6, membranous urethra cut through.
7, bulbo-urethral artery.

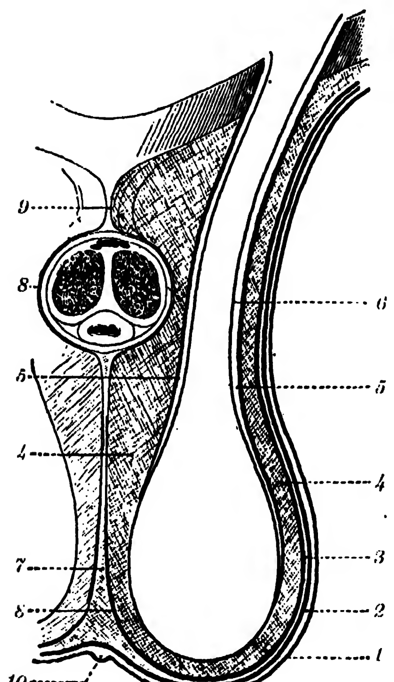


FIG. 63.—SCHEMATIC VERTICAL TRANSVERSE CUT THROUGH THE SCROTUM, SHOWING THE FORMATION OF THE SAC. (Poirier.)

1, skin, integument.
2, outer layer of dartos.
3, inner layer of dartos.
4, areolar (cellular) tissue.
5, middle spermatic or cremasteric layer.
6, internal spermatic or fibrous tunic.
7, cellular tissue between the two sides of the scrotum.
8, penile dartos sheath.
9, suspensory ligament of penis.
10, raphe.

NOTE.—The outer layer of spermatic fascia is not shown in this figure.

SCROTUM

The scrotum is the bag in which the testes and a part of the spermatic cord are contained (Fig. 63). Its outer surface is wrinkled in appearance, light brown in color and is divided in two halves by an elevated narrow band called a raphe.

Septum Scroti.—The two sides of the scrotum are further separated above by a continuation of the dartos sheath around the testes and up their inner sides to the penis, in which intervening space is a layer of cellular tissue.

Above the penis is the suspensory ligament which binds the organ to the pubes.

The scrotum is composed of several layers, and within it are the testes and

their epididymes, the former surrounded by a tunica vaginalis. The layers of the tunica vaginalis are not, properly speaking, a part of the scrotum. The scrotal layers are:

The skin (integument).

The dartos sheath, which is a red layer of fascia continuous with the dartos sheath of the penis and with the superficial fascia of the perineum and abdomen. It contains elastic tissue and unstriped muscle fibers.

The cellular tissue layer.

The outer layer of spermatic fascia which is the extension downward of the intercolumnar fascia.

The middle layer of spermatic fascia, which is the extension downward of the cremasteric muscle and fascia.

The inner spermatic fascia, which is an extension of the transversalis and is pushed down during the descent of the testes.

Tunica Vaginalis.—This consists of a parietal and visceral layer of serous membrane, forming a closed sac. The visceral layer invests the body of the testicle except behind, where the ducts and vessels are attached, being here continuous with the parietal layer that lines the inner wall of the scrotum.

TESTES

The testes are two oval-shaped bodies situated on either side of the scrotum (Fig. 64); they are separated from one another by a partial septum extending across the scrotum from before backward. They are about one and one half inches (3.7 cm.) long, one inch (2.5 cm.) in diameter from before backward, and three quarters of an inch (1.87 cm.) from side to side. Their long axis extends from below upward and slightly outward and forward; the left is normally lower than the right. On the upper and posterior borders, extending also slightly on to the outer surface, is placed a crescentic-shaped body called the epididymis. The enlarged upper end of this is the globus major (head), and the lower end is the globus minor (tail), the intermediate portion being known as the body of the epididymis. The globus major is attached to the testes by the visceral layer of the tunica vaginalis, and also by the ducts emerging from the testes at its upper end (vasa efferentia). The

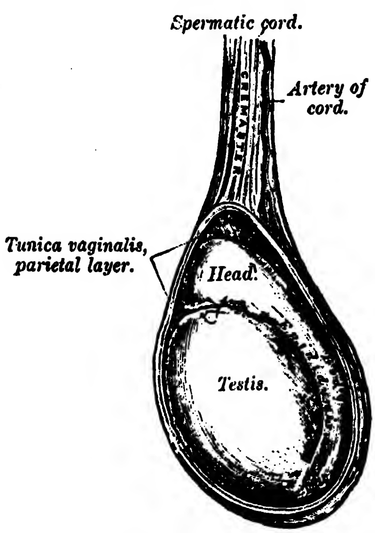


Fig. 64.—The Tunica Vaginalis Opened, Exposing the Testis with the Visceral Layer Covering It and the Parietal Layer Lining the Scrotal Tissues. (Gray.)

globus minor is attached to the lower part of the testes by areolar tissue and the visceral layer of the tunica vaginalis. The intervening portion or body is separated from the posterior border of the testes by an infolding of the tunica between it and the testes, forming the digital fossa, seen from the outer aspect. From the upper end of the testes near the globus major, are usually found two small bodies—one sessile, and one pedunculated. The former is a remnant of the Wolffian tubules, corresponding to the parovarium in the female. The pedunculated one is derived from the Wolffian duct, representing the epoöphoron in the female.

The Tunica.—The scrotum is lined by a serous sac derived from the peritoneum (tunica vaginalis). In the posterior part of the scrotum, this is reflected on to the epididymis and testicle, surrounding them except where they are in contact with each other, and posteriorly where the vessels pass to or from the testes and epididymis. The part of the sac lining the scrotum is called the parietal layer and the part covering the testes is called the visceral layer (Fig. 64).

Structure.—The testis has a complete fibrous covering, the tunica albuginea, which forms the thickened ridge on the posterior border (mediastinum). From this fibrous ridge, septa pass into the glands and divide it into compartments (Fig. 65); the glandular structure is found in these compartments and consists of a great number of minute ducts called seminiferous tubules. These unite to form the tubuli recti, which pass into the mediastinum, where they enter a complicated canal work called the rete testis. From this canal system, fifteen to twenty small ducts pass into the globus major. In the globus major these small ducts become markedly convoluted, forming conii vasculosi, and finally open into one

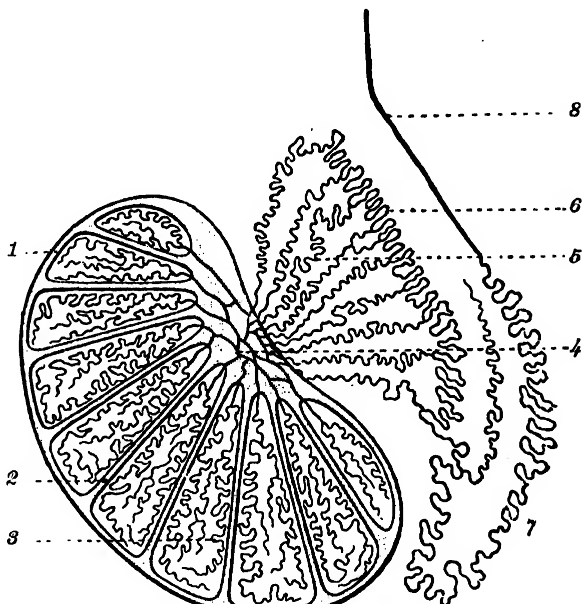


FIG. 65.—SCHEMATIC DRAWING, SHOWING THE ANATOMICAL ARRANGEMENT OF THE TESTICLE AND THE EPIDIDYMIS. (Testut.)

1, tunica albuginia.
2, the septa of the testis.
3, a lobule of the testis ending in a straight duct.
4, body of Highmore with the rete vasculosum testis.
5, efferent cones.
6, duct of the epididymis.
7, aberrant vas of Haller.
8, vas deferens.

duct called the canal of the epididymis. This in its course is greatly convoluted and coiled upon itself to form the body and especially the globus minor. If stretched out, it would measure about twenty feet. The canal of the epididymis emerges from the globus minor as the vas deferens (Fig. 66).

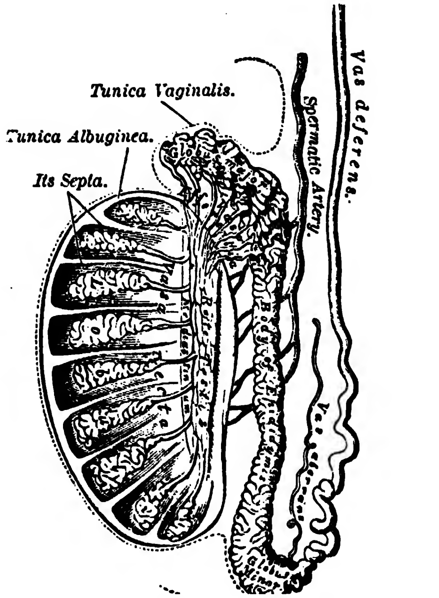


FIG. 66.—VERTICAL SECTION OF THE TESTIS AND EPIDIDYMIS, SHOWING THE LINE OF REFLECTION OF THE VISCERAL LAYER OF THE TUNICA VAGINALIS, THE TUNICA ALBUGINEA WITH ITS SEPTA, THE RETE TESTIS, MEDIASTINUM, THE EPIDIDYMIS AND VAS DEFERENS. (After Gray.)

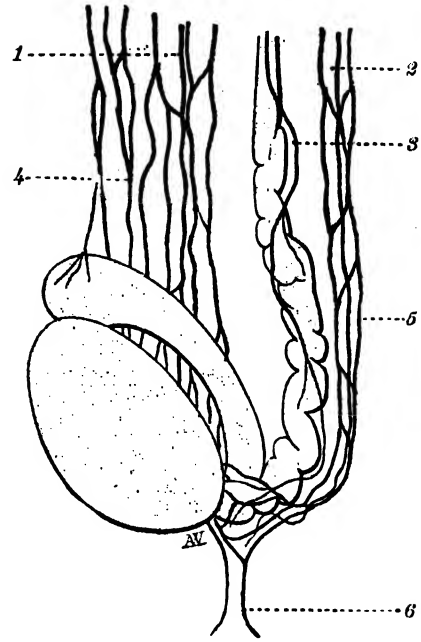


FIG. 67.—BLOOD SUPPLY OF THE TESTIS AND CORD. (After Charpy.)

1, spermatic artery.
2, cremasteric artery.
3, artery of the vas.
4, anterior group of veins.
5, posterior group of veins.
6, venous anastomosis with the superficial veins.

Blood Supply.—The testicle is supplied with blood by the *spermatic artery*. This vessel has a long course, arising from the aorta just below the renal arteries; it extends downward in the abdominal cavity to the internal abdominal ring, thence passing down the inguinal canal in the spermatic cord; it enters the testes at the upper part of its posterior border (Fig. 67). Within the gland it is distributed along the fibrous septa and beneath the tunica albuginea.

The spermatic vein forms a plexus, the pampiniform, at the posterior part of the testis and epididymis which passes upward and forward to the front part of the cord, where it is most marked. The vein then passes through the external abdominal ring, the inguinal canal and the internal ring and empties into the vena cava on the right side and the renal vein on the left.

The Spermatic Cord and Vas Deferens.—The spermatic cord is about four inches in length, and extends from the globus minor of the epididymis to the

internal abdominal ring, at which place they separate. It is made up of the vas deferens, or excretory duct of the testicle; the spermatic artery from the aorta; the artery and vein of the vas deferens; the cremasteric artery from the deep epigastric; the spermatic veins; the spermatic nerve plexus; branches of the ileo-inguinal and genito-crural nerves, and lymphatics. These structures are bound together by loose fibrous and fatty tissue, and are invested by the fasciæ, already spoken of in considering the anatomy of the scrotum, that are carried down by the testicle in its descent. The vas deferens lies below and behind the larger anterior group of veins and the spermatic artery. The mass of veins on the front of the cord, called the pampiniform plexus, unites into a single trunk, the spermatic vein, on the right side passing into the inferior vena cava and on the left side into the left renal vein. The artery of the vas deferens, derived from the inferior vesicle, is in direct relation with it; whereas the spermatic artery follows a tortuous course through the cord. The nerves are distributed throughout the cord, with the exception of filaments from the hypogastric plexus, which invest the vas

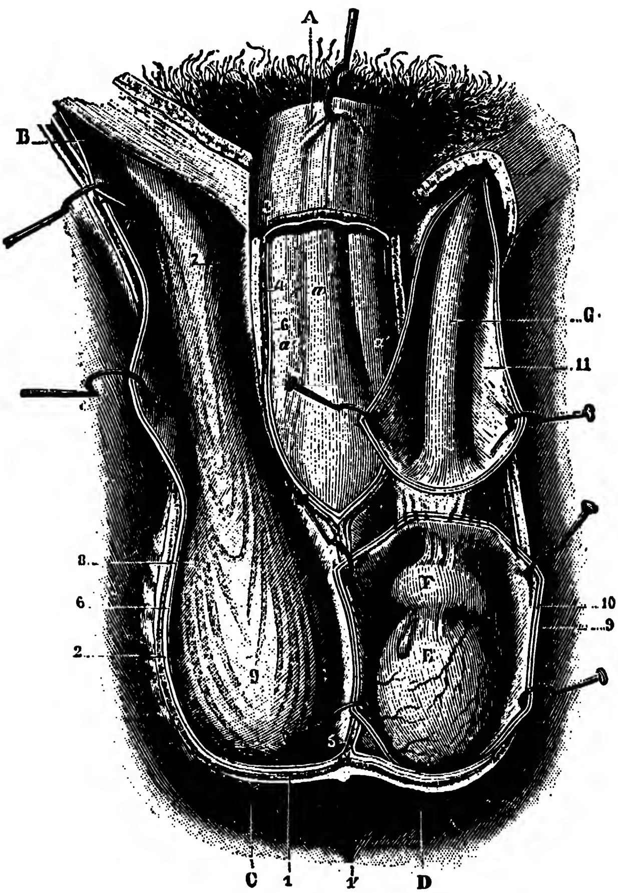


Fig. 68.—Coverings of the Testes, Seen from in Front. (After Testut.)

On the right side the scrotum and dartos have been removed to show the cremasteric muscle and fascia. On the left side the sheath of the cord and the tunica vaginalis have been cut through over the testis and retracted showing the gland and its epididymis; whereas higher up another incision shows that the peritoneo-vaginal process has not closed at this point.

A, the root of the organ pulled upward.
a, urethra.
a', *a'*, corpora cavernosa.
B, inguinal canal on the right side.
C, scrotum on the right side.
D, scrotum on the left side.
E, and *F*, testis and epididymis on the left side.
G, spermatic cord.
1', raphe of scrotum.
2, dartos.
3, skin of organ.
4, dartos layer.
5, dartos of septum.
6, cellular layer.
7, internal and external bundles of cremasteric muscle.
8, cremasteric layer of scrotum.
9, fibrous layer.
10, parietal layer of tunica vaginalis.
11, peritoneo-funicular process open.

in a rich network. The lymphatic vessels empty into the glands surrounding the lower part of the aorta and one gland lying over the external iliac artery.

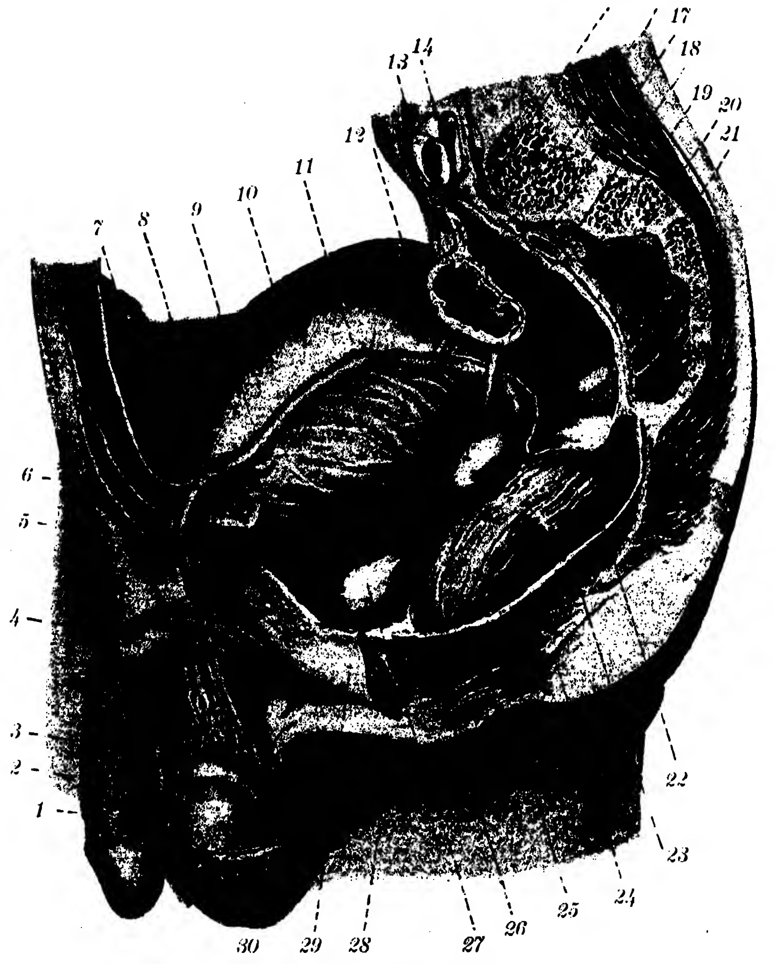


FIG. 69.—THE VAS DEFERENS EXTENDING THROUGH THE INGUINAL CANAL AND ALONG THE SIDE OF THE BLADDER TO THE EJACULATORY DUCTS. (Spalteholz.)

1, the testis.
2, the male organ.
3, the epididymis.
4, the erector penis.
5, vas deferens.
6, superior ramus of the pubes.
7, apex of the bladder.
8, parietal peritoneum.
9, obliterated hypogastro-umbilical artery.
10, peritoneum over bladder.
11, body of the bladder.
12, seminal vesicle.
13, iliac artery.
14, iliac vein.
15, mesosigmoid.
16, first sacral vertebra.
17, sigmoid.
18, mesorectum.
19, ureter.
20, ampulla of the vas.
21, recto-vesical space.
22, sacral flexure of the rectum.
23, diaphragm of the pelvis (levator ani muscle).
24, external sphincter muscle.
25, anus.
26, perineal flexure of the rectum.
27, prostate.
28, perineum.
29, inferior ramus of the ischium.
30, scrotum.

The spermatic cord (Fig. 68) derives its coverings from different layers in the abdominal wall, from within outward, the process of peritoneum, called the funicular process, being continuous below with the tunica vaginalis. Outside of this is the infundibuliform or transversalis fascia, the cremasteric fascia from the internal oblique, and the intercolumnar fascia from the external oblique.

The vas deferens (Fig. 69) is a small duct which conveys the semen from the testes to the urethra. It can be felt as a small, cordlike structure running up the posterior part of the spermatic cord; its appearance is white and glistening. A small portion of its course is within the scrotum, where it ascends on the inner side of the epididymis. It then passes through the inguinal canal with the other constituents of the spermatic cord to the internal abdominal ring. Here it winds round the deep epigastric artery, passing downward and backward on the side wall of the pelvis; it crosses the obliterated hypogastric artery and obturator vessels and nerves. Crossing inward to its termination, it raises in its course a fold of peritoneum, crosses the ureter just before the termination of the latter, and then turns downward in close apposition to the base of the bladder to the inner side of the vesiculæ seminales, to the base of the prostate, where it terminates by joining the duct from the vesiculæ seminales to form the common ejaculatory duct.

The Vesiculæ Seminales (Fig. 3).—These are situated on the basal surface of the bladder, extending from over the lower part of the ureter above to the base of the prostate below, running external to the terminal portion of the vas. The vesicle forms a convoluted mass about two inches (5 cm.) in length, and in reality is a single tube, coiled upon itself and held together by connective tissue. When opened out, it measures five or six inches in length. The vesiculæ seminales lie almost in apposition at their lower end but above are widely separated and spread outward almost horizontally between the base of the bladder and the rectum. The lower ends open into the vas to form the common ejaculatory duct. They are developed as diverticula of the vas deferens, as the gall-bladder is developed from the common bile duct.

Common Ejaculatory Duct.—This duct is a short canal, three quarters of an inch (1.8 cm.) in length, extending downward in a cleft of the prostate gland to the urethra where it opens into or at the margins of the sinus pocularis. The sinus pocularis is a small depression just below the highest part of the veru montanum, and is the analogue, in the male, of the uterus in the female.

THE PROSTATE GLAND

The prostate gland is situated in the male pelvic cavity beneath the bladder, and completely surrounds the orifice of the urethra. It is about one and one half inches (3.7 cm.) in its transverse diameter, about an inch (2.5 cm.) from be-

fore backward, and about one and one quarter inches (3.12 cm.) from above downward. In shape it is said to resemble a Spanish chestnut, and has a base directed upward, an apex directed downward, a posterior, an anterior, and two lateral surfaces. The base is firmly fixed to the under surface of the bladder (Fig. 70), the musculature of the one being directly continuous with that of the other. There is only a shallow groove between the circumference of this surface and the bladder where they are not structurally continuous. This groove is filled by several large veins.

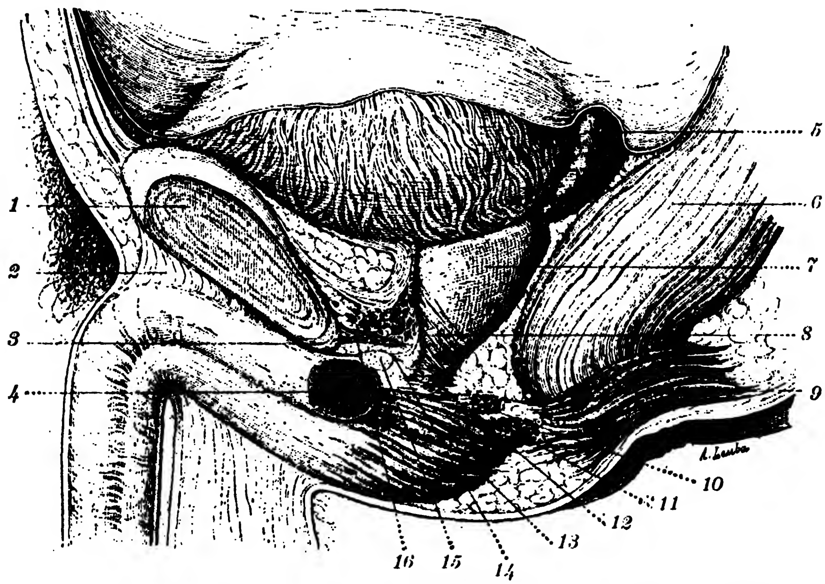


FIG. 70.—PROFILE VIEW OF THE SIDE OF THE UNOPENED PROSTATE. (Albarran.)

1, pubis.
2, suspensory penile ligament.
3, subpubic ligament.
4, root of corpus cavernosum.
5, seminal vesicle.
6, rectum.
7, prostate.
8, compressor urethra muscle, striated muscle of Henle.
9, sphincter ani muscle.
10, deep transverse perinei muscle.
11, superficial transverse perinei.
12, cut-off muscle, compressor urethra or muscle of Guthrie.
13, accelerator muscle.
14, preprostatic layer of pelvic fascia.
15, transverse pelvic ligament.
16, muscle of Wilson.

NOTE.—The muscles of Guthrie, Wilson and Henle are all associated and their fibers are connected.

The apex is the lowest portion of the gland, and rests on the superior or deep layer of the triangular ligament. The posterior surface is somewhat triangular and is separated from the rectum by pelvic fascia. The lateral surfaces are convex from behind forward and from below upward. They are covered with pelvic fascia which separates them from the levator ani. The anterior surface is narrow and rounded in its lower part. In front and a little above the apex on this surface, the urethra leaves the gland. The anterior surface occupies the space between the two levator ani muscles, and is covered by pelvic

fascia, a portion of which forms the pubo-prostatic ligament. The common ducts enter the prostate at the upper part of the posterior surface, running downward and forward to open into the prostatic urethra. The triangular portion of the gland between these ducts and the urethra is called the middle lobe (Fig. 71).

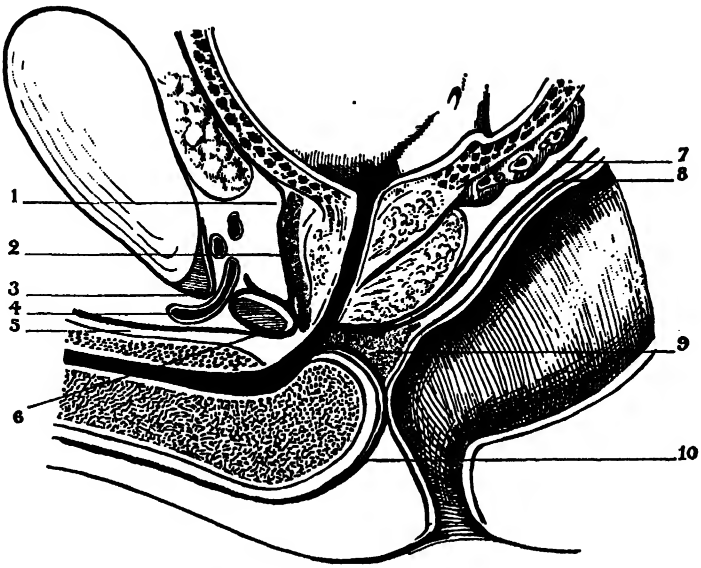


Fig. 71.—The Lobes of the Prostate and the Perineal Fascias. (Albarran.)

The so-called middle lobe is seen clearly behind the urethra and in front of the ejaculatory duct. This part of the gland bounded by the bladder, urethra and ejaculatory ducts is supposed to be the principal part of the gland involved in prostatic hypertrophy. It is simply the portion of the lateral lobes above the ejaculatory duct.

1, preprostatic layer of pelvic fascia.
2, external sphincter, prostatic segment.
3, subpubic ligament.
4, dorsal vein.
5, supraurethral fascia.
6, transverse ligament of perineum.
7 and *8*, leaflets of the aponeurosis of Denonvilliers.
9, compressor urethræ or cut-off muscle.
10, infraurethral layer of fascia.

The Relations.—It lies in front of the rectum and one and one half inches (3.7 cm.) from the anus. It is situated behind the lower part of the symphysis, at a distance of about an inch. The bladder is above it, the superior layer of the triangular ligament below it, and the levator ani muscle on either side. Immediately surrounding it is pelvic fascia forming a thick layer. A line of cleavage is made in this layer by the prostatic plexus of veins which surround the sides and base of the gland (Fig. 72). The portion of fascia outside of these veins is described as the external capsule. A thin portion of fascia is found inside the veins between the latter and the true capsule of the prostate. The gland itself is surrounded by a fibrous capsule except at the base, where it adjoins the bladder.

Structure.—It consists of two lateral lobes and a middle lobe. The lateral lobes are developed as two separate portions and in some of the lower animals remain distinct. In man, they unite together to form one mass. The so-called

middle lobe is merely the portion of gland between the urethra and common ejaculatory duct and is not marked off by any distinct separation from the lateral lobes. A true middle lobe with a distinct line of cleavage is often present.

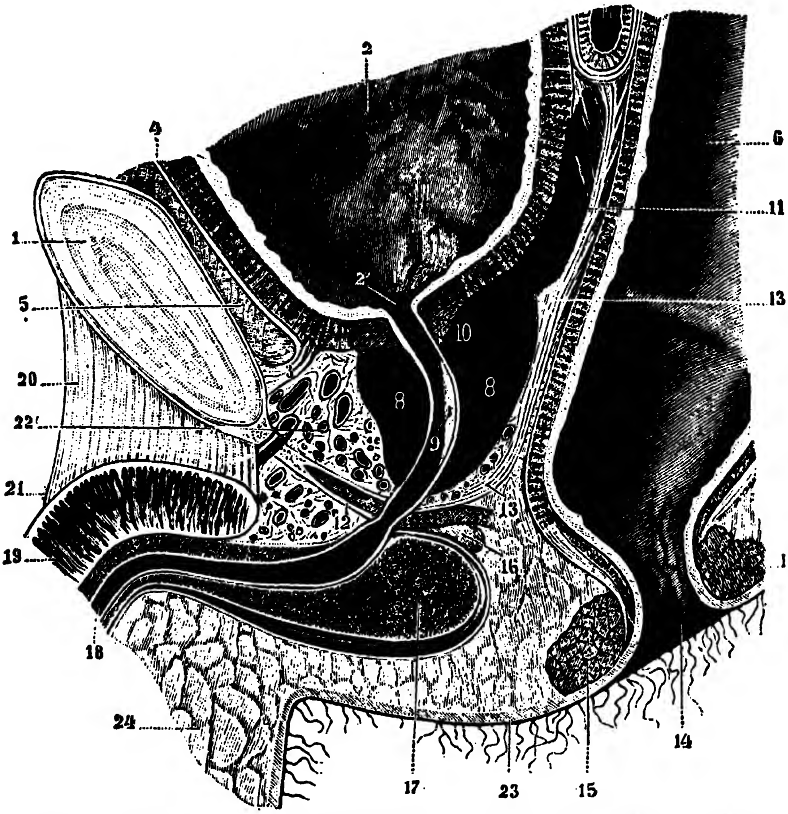


FIG. 72.—SAGITTAL SECTION THROUGH THE PROSTATE, A LITTLE TO THE LEFT OF THE MEDIAN LINE.

Note the remains of the ejaculatory (common) duct, the vesical sphincter and the plexuses of veins in this region. (Testut.)

1, symphysis pubis.
2, bladder.
2', neck of bladder.
3, anterior bladder ligament.
4, umbilico-prevesical aponeurosis.
5, prevesical space.
6, rectum.
7, recto-vesical space.
8, prostate.
9, veru montanum.
10, ejaculatory duct on the left side cut obliquely.
11, vas deferens of right side.
12, inferior layer of triangular ligament with Guthrie's muscle.
13, pelvis fascia behind prostate.
14, anus.
15, *15*, external sphincter.
16, Cowper's gland.
17, bulb of urethra.
18, spongy portion of the urethra.
19, corpora cavernosa.
20, suspensory ligament of the organ.
21, deep dorsal vein.
22, plexus of Santorini.
23, perineum.
24, scrotum.

The gland consists for the greater part of muscle fibers, that portion in front of the urethra being altogether muscular. Elsewhere, the glandular structure is found imbedded in the muscular compartments. This consists of minute

tubules lined with columnar epithelium. These open by about twenty ducts into the urethra on either side of the veru montanum.

Blood Supply.—The prostate is supplied with blood by the inferior vesical and inferior hemorrhoidal arteries. The blood is returned by the prostatic plexus of veins, which empties into the vesical plexus.

Lymphatics.—The lymphatic return goes to the iliac glands.

Nerves.—The nerve supply of the prostate comes from the hypogastric plexus.

THE PENIS

The penis consists of three longitudinal columns of erectile tissue; two of the columns, the corpora cavernosa, much larger than the third, are placed side by side, while the third column, the corpus spongiosum, is placed on the under surface in a groove between the other two. It is through this portion that the urethra passes (Fig. 73).

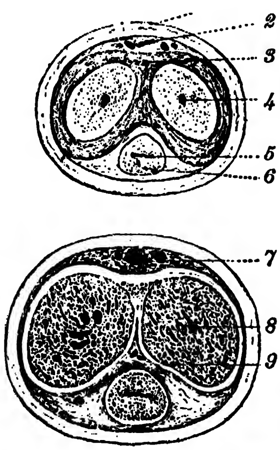


FIG. 73.—PENILE URETHRA IN THE STATE OF REPOSE AND ERECTION. (From Poirier.)

1, cutaneous layer.
2, dorsal vein, flanked on each side by dorsal artery and nerve.
3, tunica albuginea.
4, artery of the corpus cavernosum.
5, urethra.
6, corpus spongiosum.
7, dorsal vein.
8, artery of corpus cavernosum.
9, venous plexus.

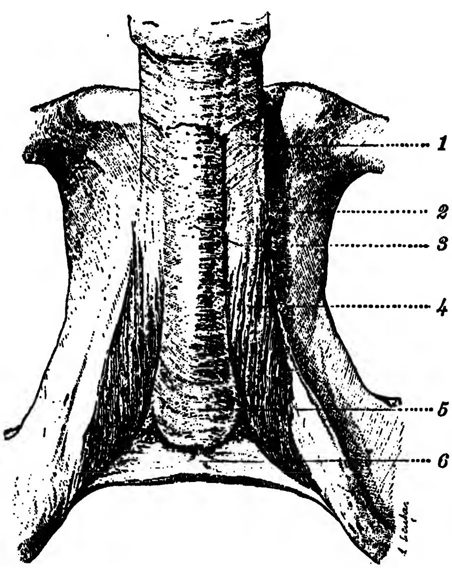


FIG. 74.—ROOTS OF THE PENIS. (From Poirier.)

1, the annular fibers of the suspensory ligament.
2, pubis.
3, the fibers of the suspensory ligament descending to scrotum.
4, the erector penis muscle.
5, the bulb of the corpora spongiosum.
6, the central fibrous tendon of the perineum.

Roots of Penis.—The corpora cavernosa arise from the ascending ramus of the ischium on either side, and are covered by the ischio-cavernosus muscle (Fig. 74). They extend forward and inward, uniting with one another and the corpus spongiosum to form the body of the penis. The corpus spongiosum at its origin consists of an expanded portion called the bulb, which is covered by

the ischio-bulbosus muscle and rests against the triangular ligament, the middle of the urogenital triangle. This proceeds forward in the mid line of the perineum to join the corpora cavernosa. At its distal extremity the corpus spongiosum becomes expanded and forms a cap which fits over the conical extremities of the corpora cavernosa. This is known as the glans penis (Fig. 75). It slightly overlaps the corpora cavernosa and this projecting border is known as the corona glandis. At the summit of the glans and slightly on its under surface, is the meatus urinarius or external opening of the urethra (Fig. 76).

The three columns of the penis are bound together by fibrous tissue, each of the parts having a separate covering. Between the corpora cavernosa, the fusion of this covering forms an incomplete septum—the septum pectiniformæ.

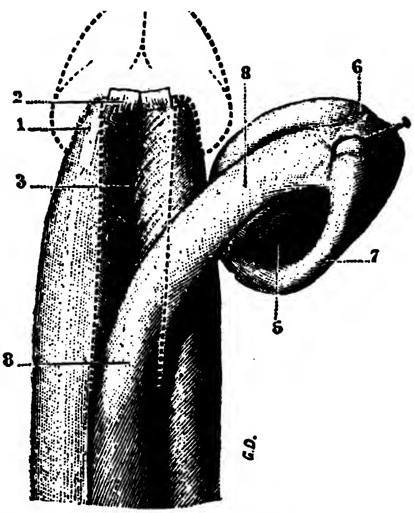


Fig. 75.—Manner of Union of the Anterior End of the Corpora Cavernosa with the Glans. (After Testut.)

The anterior ligament has been cut through and the glans pulled to one side.

1, anterior extremity of the corpus spongiosum.
2, anterior ligaments.
3, urethral gutter between the corpora cavernosa.
4, *5*, glans with posterior capsule.
6, the cleft in its lower part.
7, its corona.
8, corpus spongiosum of the urethra.

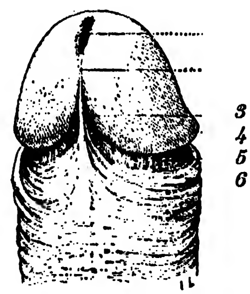


Fig. 76.—The End of the Penis. (From Poirier.)

1, the meatus.
2, the frenum.
3, fossa beside the frenum.
4, the corona.
5, balano-preputial sulcus.
6, prepuce.

The penis is covered with skin, which is loose and freely movable, to allow for expansion of the organ. It is continued over the glans as a thin, firmly attached layer, resembling mucous membrane, and frequently described as such. From behind the corona glandis, a double fold of delicate skin is formed which covers over the glans in the flaccid condition of the penis. This is known as the prepuce, and disappears in the erect condition. The skin over the body and glans then appears in its true continuity. From just below the meatus, a small fold of skin, the frenum preputii, passes to the under surface of the prepuce. The inner surface of the prepuce and posterior portion of the skin over the glans contains sebaceous glands which secrete smegma.

Suspensory Ligament.—A band of fibrous tissue extends from the symphysis pubis to the penis, and is attached to its fibrous capsule. This is the suspensory ligament. At its attachment it separates into two parts and through the space thus formed pass the dorsal vessels and nerves.

Structure.—Each column of the penis is made up of fibrous covering containing many elastic fibers, and within this capsule an irregular spongework of fibrous trabeculæ are formed. The interstices of the spongework consist of blood spaces lined by endothelium and empty directly into the veins. Hence the size of the organ is subject to great variation, depending upon the amount of blood contained within this spongework.

Blood Vessels.—The arterial supply comes from the branches of the internal pudic; these are the artery to the bulb, the arteries to the corpora cavernosa, and the dorsal artery of the penis. The glans is supplied by the dorsal artery which is a continuation of the internal pudic. The veins empty directly into the prostatic plexus or into the dorsal vein, which itself empties into the prostatic plexus. On the upper or dorsal surface, in a groove between the corpora cavernosa, the dorsal vein is situated. On either side of the vein are the dorsal arteries and just outside of these are the dorsal nerves.

Lymphatics.—These go to the inguinal glands.

Nerves.—The dorsal nerve and superficial perineal nerves from the internal pudic nerve supply the skin, while the hypogastric plexus, indirectly through the prostatic plexus, supplies the erectile tissues.

In the female, the clitoris is the analogue of the penis. It is very small in comparison, and consists of only two columns, the corpora cavernosa. The bulb of the vagina is the analogue of the bulb of the penis; it is, however, split in two by the passage of the vagina, and has a separate ischio-bulbosus muscle covering each part. The bulbs of the vagina unite in front between the urethra and clitoris to form a venous plexus, which is continuous with the glans clitoridis.

CHAPTER III

THE URINE

In treating of the subject of urine, it is not my intention to give it the comprehensive and exhaustive consideration demanded by a text-book on urine analysis. The examination of the urine will be gone into chiefly with reference to its bearing on pathological conditions noted in genito-urinary surgery. I shall, however, not lose sight of the importance of so-called medical pathological conditions, because we find that the kidney diseases heretofore considered strictly within the domain of medicine have begun to enter the surgical field. Moreover, in the surgical diseases of the kidney due to pressure, irritation, new growths or pathological deposits, an associated nephritis is wont to occur.

Diseases of metabolism do not come within the scope of this work, excepting so far as they may be considered associated with the subject or must be differentiated from diseases having symptoms in common with them.

We will briefly discuss the characteristics and the constituents of normal urine before proceeding to take up the various pathological changes. The card used in my laboratory will serve as a guide, as it indicates the point of view from which we regard the subject. We will give the tests used in our routine work and mention the others only by name, in order that they may be studied in text-books on urinary analysis, if the reader desires. There are many topics not mentioned on the card that will be spoken of and their importance briefly considered.

I. GENERAL CONSIDERATIONS

The normal urine is a transparent fluid of an aqueous consistency, of a pale yellow color, with a characteristic odor and acid reaction, and a specific gravity of from 1.018 to 1.025 at 60° F. Few of these characters are so fixed that a slight variation signifies disease. The diet, the weather, the occupation of the patient, may change the features of the urine within certain limits in health. On the other hand, great and persistent departure from the above standard usually means that either the kidneys or the other urinary organs are diseased, or that the organism as a whole is deranged.

II. COMPOSITION AND PROPERTIES OF THE URINE

The constituents of the urine are derived from two sources: from the catabolism of the tissues of the body and from the waste of ingested food and liquids.

The following table (from Parkes) shows the composition of normal urine, together with the amount of each constituent excreted in twenty-four hours:

Water	1,500.00 gms.	50 oz.
Total solids	72.00 "	1,110.96 grs
Uric acid	0.55 "	8.4 "
Hippuric acid	0.40 "	6.1 "
Creatinin	0.91 "	14.04 "
Pigment and minor organic matters	10.00 "	154.00 "
Sulphuric acid	2.01 "	31.00 "
Phosphoric acid	3.16 "	48.75 "
Chlorine	7.80 "	108.01–123.44 "
Ammonia	0.77 "	11.88 "
Potassium	2.50 "	38.57 "
Sodium	11.09 "	171.11 "
Calcium	0.26 "	4.01 "
Magnesium	0.21 "	3.24 "

Selection of Specimens of Urine for Examination.—For accurate urinary analysis, either the total amount of urine passed in twenty-four hours or a sample taken from the entire quantity, is collected in a clean half-gallon bottle, kept in a cool place, well corked. In either case, the quantity eliminated in twenty-four hours should be measured. If this is impossible, a four-ounce specimen of the night and morning urine should be obtained. The urine passed in the morning after a night's rest, is least likely to contain albumin or sugar. Voided urine, if allowed to stand warm and in an open vessel, becomes opaque in from twenty-four to forty-eight hours by the multiplication of bacteria, which change the urea to ammonium carbonate.

Preservation of Specimen.—Urine should be examined in as fresh a state as possible. If it has to be kept more than a few hours, some antiseptic must be added. The best method in the author's hands, has been the addition of a crystal or two of thymol. The addition of an ounce of saturated solution of boric acid, or two five-grain tablets of the same to a quart of urine, is preferred by some; others recommend five grains of salicylic acid to four ounces of urine. A drachm of chloroform to four ounces of urine is also effective. Formalin is sometimes used, but cannot be recommended, as it interferes with the examination.

Physical Properties of the Urine.—Amount in Twenty-four Hours.—The amount of urine voided in twenty-four hours by a healthy adult averages from 1,200 to 1,600 c.c., the mean figure being about 1,400, forty-eight fluid

LABORATORY OF DR. RAMON GUITERAS, 80 MADISON AVE.

Urine of............................ Address...............................

Date............................... Report to be sent to ....

PHYSICAL EXAMINATION.

Amount in 24 hours.	Spontaneous.	By Catheter.
Color.	Odor.	Transparency.
Reaction.	Specific gravity.	Total solids.

CHEMICAL EXAMINATION.

Albumin.		Serum.	Nucleo.	Quantitative.
Sugar.		Fehling test.		Quantitative.
Urea.		Per cent.		Grains to ounce.
Uric acid.			Urates.	
Diacetic acid.		Aceton.		Indican.
Bile pigment.			Other organic elements.	
Chlorids.	Carbonates.		Phosphates.	Sulphates.

MICROSCOPICAL EXAMINATION.

Amorphous deposits.			
Crystalline deposits.			
Red blood corpuscles.		Leucocytes.	
Pus.			
Mucus.	Tissue.	Shreds.	Fat globules.
Epithelia.			
Casts.			
Cylindroids.		Other elements.	
Microörganisms.			
Diagnosis from urine analysis.			

Remarks:

FIG. 77.—URINE ANALYSIS CHART.[1]

ounces, or three pints. Roughly speaking, the kidneys secrete two ounces an hour, that is, one ounce each. Children pass relatively larger amounts than adults. One kilo of the body excretes on the average of 1 c.c. of urine per hour. Women pass smaller quantities than men, on account of their smaller average size. By taking violent exercise, by abstaining from drinking water, etc., and by promoting free perspiration, the excretion is diminished, but the density is increased. The amount is sometimes markedly increased after emotions (joy, grief, fright), and varies also at different times during the day. The largest amount of urine is usually passed in the afternoon, a moderate amount in the forenoon, and the smallest amount at night. In warm weather, much smaller amounts are passed than during the cold months.

COLOR.—The color of urine varies considerably even in health. The color is due to the presence of urochrome and urobilin. Diluted urines are usually pale; concentrated urines are dark. The color may be changed by drugs, the

[1] The accompanying charts are used by the author in recording urinary examinations. They may be kept printed in blank form, as illustrated, and filed with the history of the case.

amount of water drunk and the other factors influencing quantity, and sometimes by the quality of the food.

The color of the urine is markedly pale and forms a diagnostic feature in chronic interstitial nephritis, diabetes mellitus and insipidus.

In acute fevers and in congestion of the kidneys it is highly colored, due to concentration of the urine. A dark brownish-red color is often characteristic of hemorrhage from the kidney. Hemorrhage from the bladder or ureters gives the urine a bright-red color.

ODOR.—The odor of the urine is characteristic and cannot be compared with any other. Certain variations from the normal are significant of disease. If freshly voided urine is putrid or ammoniacal, there must have been decomposition in the bladder or above this organ, as is often the case in pyelitis and cystitis.

When large quantities of pus are present, the odor is sulphuretted, owing to the decomposition of the albuminous substances. In diabetes mellitus, the urine usually has a peculiar aromatic odor. Certain foods and drugs, such as asparagus, garlic, the balsams of copaiba and Peru, turpentine, saffron, etc., impart easily distinguishable odors to the urine.

TRANSPARENCY.—Normal urine, freshly voided, is always perfectly transparent. On standing a few minutes, a faint cloud often appears, known as the *nubecula*, which floats in the center or sinks to the bottom. It consists of mucus, bacteria and epithelial débris. In women, vaginal mucus is mixed with the urine and may cloud it considerably; and in catarrhal and other inflammatory conditions of the genito-urinary tract, the normal mucous cloud may also be increased. The urine is then cloudy from the first on being voided. The normal mucous cloud is distinct from other causes of turbidity to be mentioned.

CLOUDINESS in urine may result from (1) bacteria, (2) phosphates, (3) urates, (4) pus, and (5) fat. The following table shows the shortest methods of differentiating the causes of cloudiness by means of simple reagents.

Differentiation of the Principal Causes of Turbidity in the Urine.

(1) Heat the urine for a few seconds:

(*a*) Turbidity increases or precipitate forms: *bacteria, mucus, phosphates* or *pus.*

(*b*) Turbidity disappears: *urates.*

(2) Add acetic acid:

(*a*) Turbidity unchanged: *bacteria, urates.*

(*b*) Turbidity increased or precipitates: *mucus* or *pus,* or both.

(*c*) Dispelled at once: *phosphates.*

(3) Add potassium hydrate:

(*a*) Turbidity or precipitate disappears: *urates.*

(*b*) Is changed to a gelatinous coagulum: *pus.*

Reaction.—In herbivora, the urine is alkaline; in carnivora, acid. In man, on a mixed diet, it is normally acid. The acidity depends upon the food ingested and is due chiefly to the presence of acid sodium phosphate and hippuric acid. The acidity varies at different times of the day in regular sequence diminishing soon after meals, it changes in about three or four hours, when the urine may become alkaline. Alkaline salts or vegetable acids in the food increase the alkalinity, the acids being converted into carbonates (alkaline salts) in the blood. An excess of meat in the diet will increase the acidity, while a vegetarian diet produces alkalinity.

The acidity is tested by means of red and blue litmus paper; the blue turns red in acid urine; the red turns blue in alkaline urine.

Specific Gravity.—The specific gravity of normal urine is between 1.012 and 1.024; the standard normal average 1.020 at 60° F. It varies in health, according to the time of day, the meals and the amount of exercise, the amount of fluid drunk and the total amount of urine passed daily, as well as the amount of solids excreted. Therefore, to measure specific gravity accurately, allowances must be made for the conditions of diet, exercise, etc.

The specific gravity of urine is increased by an excess of nitrogenous food, by sweating and muscular exertion. A lower specific gravity with absence of albumin or sugar, means less urea; it also means an increased quantity of urine, except in heart disease and in the last stages of chronic Bright's disease, when combined low quantity and specific gravity is a grave sign.

Determination.—The specific gravity is best determined by means of a special hydrometer, known as a urinometer. (See Fig. 78.) Before testing, the urine should be allowed to cool to room temperature, for when just voided, it has about the temperature of the body. A sufficient amount of urine is filtered into the cylinder accompanying each instrument, and the urinometer, carefully cleaned and aired, should be immersed gently with a slight spinning turn, which prevents its adhesion to the sides of the vessel. Any foam on the surface of the urine may be removed by means of filter paper. To read the urinometer, we must read the line at the level of the lower portion of the *menisci* formed at the contact of the urine with the stem.

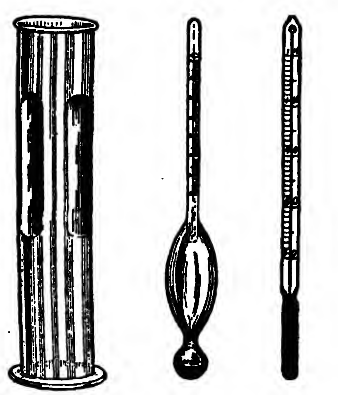


Fig. 78.—Squibbs Urinometer, with Thermometer and Cylinder.

An instrument for the estimation of the specific gravity of about 3 c.c. of urine with clinical accuracy, was devised by De Santos Saxe while working in my laboratory, principally with the object of estimating specimens of urine taken from the kidney by the ureteral catheter. It is known

as the pyknometer.[1] This consists of a flask with a well-fitting glass stopper, the head of which bears a small bead of mercury. (See Fig. 79.) This flask is fixed to one pole of a small spheric bulb, to the other pole of which is attached the stem of the instrument. The mark 1,060 is at the top of the stem, and the mark 1,000 at the bottom, so that the instrument is graduated in reverse order as compared to the ordinary hydrometer. When the flask is filled with distilled water up to the mark "M" and when the instrument is closed and immersed in distilled water, it reads at 1,000. When urine is poured into the flask instead of distilled water up to the same mark, the instrument sinks in distilled water in proportion to the specific gravity of the urine, which is then read on the scale in the same way as the ordinary urinometer.

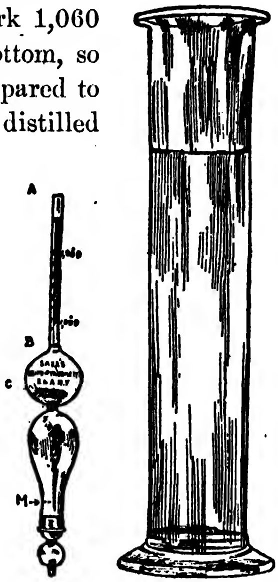


FIG. 79.—SAXE'S URINOPYKNOMETER AND CYLINDER. (Eimer & Amend.)

TOTAL SOLIDS.—The amount of total solids in the twenty-four hours' urine determines the specific gravity. The specific gravity, as a rule, varies in proportion to the amount of solids, but in certain diseases the watery element of the urine predominates, without any marked change in the amount of solids in the twenty-four hours' specimen.

For clinical purposes, the amount of total solids in the twenty-four hours' normal urine can be determined approximately by multiplying the last two figures of the specific gravity by Haeser's coefficient, which is 2.33, and thus obtaining roughly the number of grams of solids in 1,000 c.c. (1 liter) of urine. This number, multiplied by the number of c.c. passed in twenty-four hours and divided by 1,000, gives in grams the amount of solids eliminated in twenty-four hours.

A much more accurate method of determining the amount of solids is to evaporate a given amount of urine in a previously weighed porcelain dish, drying the residue, cooling and weighing repeatedly until there is no further loss of weight from drying.

The average amount of excretion in twenty-four hours by a person weighing 145 pounds (66 kilos), is 945 grains (61.25 grams). This applies to an ordinary diet of mixed food and to a healthy man taking ordinary exercise. One third should be deducted for persons who have fasted for two days or longer; one eighth if the diet be spare; one tenth for perfect rest; one twentieth for comparative rest. According to Parkes, the amount of solids excreted begins to diminish after forty and sinks to fifty per cent of the normal above seventy years of age.

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[1] Made by Eimer & Amend, New York City.

III. CHEMICAL EXAMINATION OF THE URINE

The Proteids

The proteids found in the urine under various conditions are:

Serum albumin.	Fibrin.
Nucleo-albumin.	Albumose.
Serum globulin.	Peptone.

Albumin

Serum albumin is the most important abnormal proteid found in the urine. Albuminuria has reference to the presence of serum albumin of the blood in the urine, and serum albumin is usually significant of deranged renal function or pathological changes in the kidney. Serum albumin is occasionally found in certain individuals under apparently perfect normal conditions. Traces may also appear in healthy individuals after excessive exercise, overindulgence in meats or a diet of eggs.

Nucleo-albumin is a compound of a proteid and nuclein contained in cell protoplasm. In the urine it is derived from the nuclei of epithelial cells and leucocytes. The organic débris of normal urine includes more or less of this cellular element and consequently it is possible by delicate tests to detect minute traces of nucleo-albumin in normal urine. In inflammatory conditions of the urinary tract where there is considerable amount of pus and epithelium present, nucleo-albumin is abundant. Where this is the case and when at the same time the urine is to be examined for possible evidence of kidney derangement or disease, it becomes very important to differentiate the serum albumin from the nucleo-albumin. Under the tests for albumin, a method of procedure will be given.

Qualitative Tests for Albumin.—Nitric-Acid Test (*Heller's*).—Pour a small quantity (5 to 10 c.c.) of nitric acid in a test-tube. Hold the tube in a slanting position and with a pipette allow about an equal amount of filtered urine to slowly trickle down on top of the acid. If albumin is present, a white line appears at the junction of the two liquids. If the amount present is large, there is at once a wide band formed. This test is quite sufficient for ordinary purposes. It is not only reliable in determining the presence or absence of albumin, but it also gives evidence as to the presence of other properties, to wit:

Excess of indican: *purple band.*

Bile pigment: *green band.*

Uric acid: *faint waving ring* above the juncture of the liquids.

Mucin: *a cloudy band* still higher up above the acid.

Should the above test give doubtful reactions, the following sensitive tests can be employed.

Potassium-Ferrocyanid Test.—To a test-tube of filtered urine add five to ten drops of acetic acid and a few drops of a ten-per-cent ferrocyanid-of-potassium solution. If albumin is present, a cloudiness will at once appear. Very delicate in doubtful cases.

Trichloracetic-Acid Test.—This is one of the most delicate tests known. It is often possible to demonstrate minute traces of albumin, with this test, in urines containing a few casts when the common tests fail to show any reaction. To a test-tube containing the filtered urine, add with a pipette 1 or 2 c.c. of a solution of trichloracetic acid, depositing the reagent carefully at the bottom of the tube beneath the urine. (Specific gravity of the reagent equals 1.147.) A white zone at once forms at the junction of the two liquids if albumin is present. Albumose and excess of uric acid also show a reaction, but the former disappears on boiling and the latter on heating.

Serum-Albumin Test.—Reference has already been made to the fact that, in genito-urinary work, it becomes necessary frequently to differentiate the nucleo- from the serum-albumin. This can be done very readily by the following method:

"Nucleo albumin is not precipitated by heat and acid in highly salted urines. To prove serum albumin, therefore, to the urine add one fifth volume of saturated sodium-chlorid solution, heat the upper one third, add two to five drops of fifty-per-cent acetic acid, heat a second time. A persistent cloud equals serum albumin." [1]

Quantitative Estimation of Albumin.—The absolutely accurate quantitative methods of testing for albumin are entirely too elaborate for clinical work. They will be found described in the handbooks on urinary analysis.

Fig. 80.—Esbach's Albuminometer.

Esbach's Method.—This is a convenient method of quantitative estimation, which is sufficiently accurate for clinical purposes. The apparatus is a graduated glass tube (albuminometer, Fig. 80) which is filled with urine to the letter "U." Esbach's reagent is added up to the mark "R." (This reagent consists of picric acid, ten parts; citric acid, twenty parts; and distilled water, one thousand parts.)

The tube is closed with a rubber stopper and the contents mixed by inverting it several times. The number at the level of the precipitate, read after allowing the tube to stand for twenty-four hours, shows the number of grams of albumin contained in one liter of urine. Each gram represents one tenth of one per cent by weight. When large quantities of albumin are present (over 0.7 per cent, the highest mark on the scale), the urine must

[1] Hastings, *New York Medical Journal*, July 7, 1906.

be diluted with equal parts of distilled water, and the results multiplied by two.

This method is not absolutely accurate for the reason that picric acid also precipitates urates, peptone and vegetable alkaloids.

Serum Globulin

Serum globulin is nearly always present together with serum albumin, and usually it is not necessary to differentiate them. Excess of globulin, however, as compared to the amount of albumin, is noted in catarrhal cystitis, in acute nephritis, and particularly in amyloid degeneration of the kidney. In chronic nephritis, globulin is scant or even absent.

Tests for Globulin.—The urine is accurately neutralized by adding alkali or acid, as the case may be; is filtered and is completely saturated with magnesium sulphate at ordinary temperature, a white precipitate immediately forming with globulins. If this precipitate be filtered off, the same urine may be tested for serum albumin by heating with a few drops of acetic acid.

Fibrin

Fibrin is an elastic, white, stringy albuminous substance, insoluble in water and alcohol. It is soluble in solutions of magnesium sulphate, with the formation of globulin, and by the addition of strong acid it is converted into acid albumin. When found in the urine, fibrin means the presence of blood. A urine containing fibrin may coagulate spontaneously on standing. It is important to distinguish between fibrin and the gelatinous mass formed by pus. The nature of the clot can be determined chemically by Millon's reagent, but the point can be settled much quicker by a microscopical examination.

Albumose

Albumose is an intermediate product between the original proteid (albumin) and the final products of digestion (peptone). Albumose is not coagulable by heat; is precipitated but not coagulated by alcohol. It is precipitated by nitric acid, the precipitate thus formed being temporarily dispelled by heat. It does not usually occur in ordinary albuminuria. It occurs in the urine in febrile diseases and in septic conditions, such as empyema, in intestinal ulcers, and ulcerating malignant growths.

There is a very rare form of albuminuria which occurs only in myelosarcoma of the bones and is often spoken of as Bence-Jones albuminuria.

Mucus

A small amount of mucus is present in normal urine. Under the microscope this mucus is seen to be composed of mucous threads—transparent, homogenous, stringy masses. Mucus is a normal product of epithelial cells and is, therefore, always found in the urine. An increase in the normal amount of mucus is one of the first evidences of irritation somewhere along the urinary tract. This may be due to highly acid or highly concentrated urine, or to the presence of irritating crystals.

Mucin

Mucin is the chemical basis of mucus and forms the great bulk of the so-called nubecula or mucous cloud occurring in normal urine. The amount of mucin is greatly increased in pathological urines, owing to the presence of irritation of the surface of some part of the genito-urinary tract. Mucin is precipitated by acetic acid and is distinguished from nucleo-albumin in that it is soluble in a slight excess of the acid. The presence of mucin does not interfere with the ordinary albumin test, as it is dissolved in an excess of Esbach's and other reagents.

Carbohydrates

Glucose

The occurrence of sugar in the urine is especially of interest to the urologist, on account of its association with polyuria and may, therefore, be a cause of frequency of urination. The polyuria may have escaped the patient's notice, because people voiding their urine in urinals and closets are not aware of how much they are passing each time. It is, therefore, important to include sugar tests as a matter of routine in every urine examination.

Qualitative Tests for Sugar.—Fehling's Test.—The reagent consists of two parts which must be kept in separate bottles, in a dark place:

I. Copper Solution (Tyson)

Copper sulphate	34.652 gm.
Distilled water	500 c.c.

II. Alkaline Solution (Tyson)

Sodium potassium tartrate (Rochelle salt)	175 gm.
Sodium hydrate solution (specific gravity 1.120)	480 c.c.
Distilled water, enough to make	500 c.c.

(The sodium hydrate solution contains 52.727 gm. of caustic soda and enough distilled water to make 500 c.c.)

In testing for sugar, dilute 1 c.c. of each of these solutions in about four times the amount of water and boil the mixture for a few seconds. If the solution becomes clouded on boiling, the reagents should be freshly prepared. If the solution remains clear, the suspected urine should be added drop by drop. If sugar is present in considerable amount, the first two drops will cause a yellow or red precipitate of copper suboxid.

One should continue to add the urine until an amount has been added equal to the reagent, and then boil it. If no precipitate occurs within thirty minutes, allow the tube to stand for a day for possible traces of sugar.

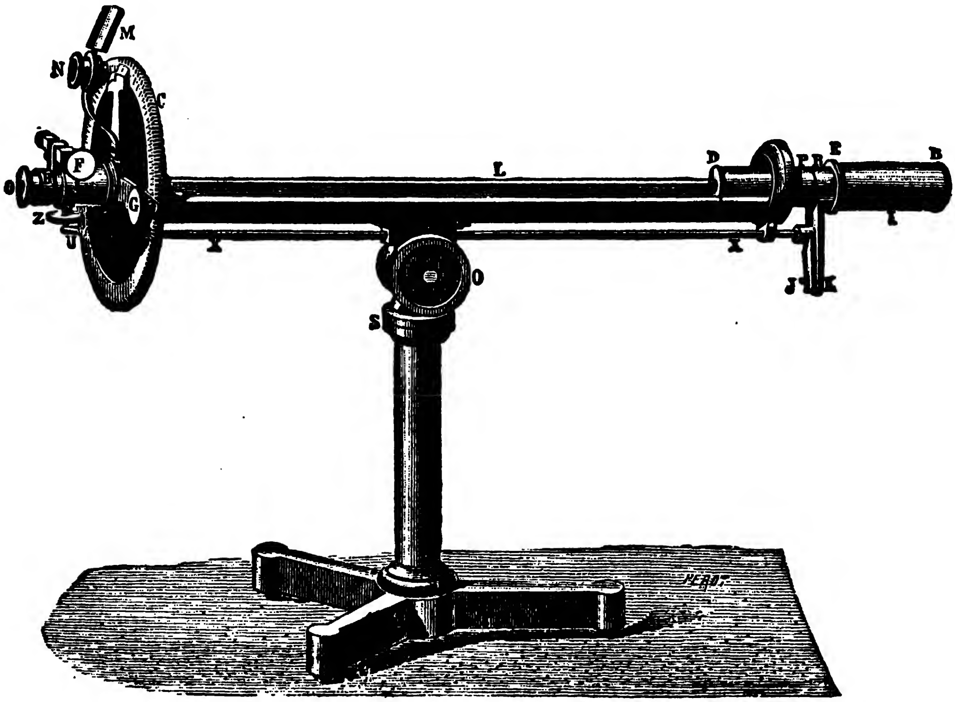


Fig. 81.—The Laurent Penumbra Polarizing Saccharometer. (From Tyson.)

An improved solution consists of thirty grains of copper sulphate, half an ounce of distilled water, half an ounce of pure glycerin, and five ounces of potassium-hydrate solution. Boil a dram of this solution in a test-tube, and add eight drops of the urine. Boil the mixture gently, and if sugar is present, a yellow or yellowish-red precipitate appears.

Nylander's Test.—This test reveals sugar in amounts of 0.1 per cent or over and can be strongly recommended for the use of the practitioner. It is easily performed and the solution keeps perfectly for many months. The solution is composed of bismuth subnitrate, 2 parts; Rochelle salts, 4 parts; sodium

hydrate (sticks), 8 parts; water, 100 parts. One part of this solution is added to 9 parts by volume of the urine and the mixture boiled in a test-tube for one or two minutes. The reaction begins as a grayish-black coloration which soon becomes deep black.

POLARIMETRY is a convenient and quick method for the quantitative determination of glucose when it exceeds 0.5 per cent. The urine must be clarified before testing. The test depends on the fact that glucose rotates polarized light to the right, and the proportion of sugar in solution is determined by the degree of deviation noted. The polariscope of Laurent, made by Schmidt & Haench, of Berlin, is probably the most useful (Fig. 81).

PHENYL-HYDRAZIN TEST (*Williamson's Method*).—Fill a test-tube of ordinary size for about half an inch with powdered phenyl-hydrazin hydrochlorate; then add another half inch of powdered sodium acetate. Fill half the test-tube with urine, and boil it over a spirit lamp for about two minutes. The powders dissolve and the tube is allowed to stand to deposit a yellow sediment. This, under a microscope, is seen to consist of bright yellow needle-shaped crystals arranged in sunburst fashion (phenyl-glucosazone). They are almost insoluble in water, but dissolve in boiling alcohol.

PRECAUTIONS IN TESTING FOR SUGAR.—In testing for sugar, all utensils must be perfectly clean, and albumin must be removed if present in any considerable quantities. In using the copper test, always add to the boiling solution as few drops of the urine as possible, waiting a moment or two before adding a few more drops, and so on, until equal parts of the reagent and the urine are used. If the urine is boiled with a copper solution, there may be a greenish color, or a greenish opacity, or even a brownish color without the presence of sugar. An excess of copper sulphate or too strong a solution should not be used, because they give rise to these precipitates without any sugar.

Quantitative Tests for Sugar.—FERMENTATION TEST.—By fermenting urine with yeast, the sugar is decomposed into alcohol, carbon dioxid, etc., with a decrease in the specific gravity of the urine. Each degree lost is equivalent to one grain of sugar to the ounce of urine.

ROBERT'S METHOD.—Into a twelve-ounce flask, put four ounces of urine and a small lump of yeast; cork the bottle with a nicked cork to allow the carbon dioxid to escape; set it aside in a warm place to ferment. With it, put a tightly corked four-ounce flask of the same urine without yeast, for comparison. After eighteen to twenty-four hours, the fermented urine is decanted and the specific gravity noted. At the same time the specific gravity of the unfermented urine is taken. The former subtracted from the latter shows the degree of gravity lost, which may be read at once as grains of sugar per ounce. Or else, the number of the lost degrees may be multiplied by 0.23 to obtain the percentage. The chief objection to this method is that it requires too much time.

Lohnstein's saccharometer (Fig. 82) is a very accurate fermentation apparatus devised for urines containing large quantities of sugar. It is provided with a scale graduated for sugar percentages at two different temperatures and is so constructed that the fermenting urine is separated from the outside air by a column of mercury. It thus avoids the errors made in the use of the Einhorn saccharometer at widely differing temperatures.

Einhorn's saccharometer (Fig. 83) is used in sets of two, one being

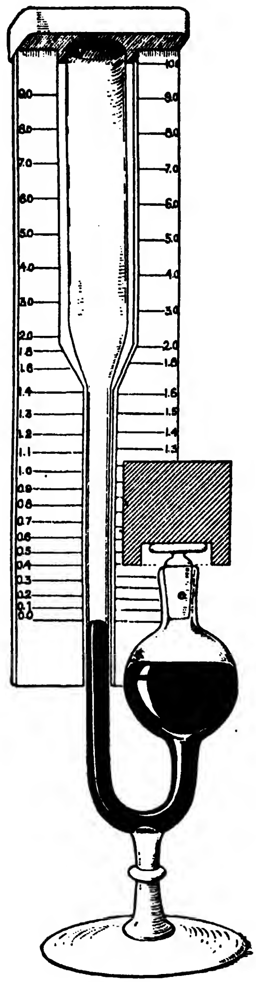


Fig. 82.—Lohnstein's Saccharometer for Undiluted Urine. (From Wood.)

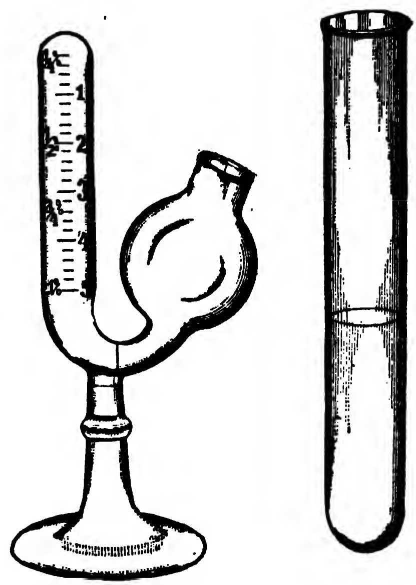


Fig. 83.—Einhorn's Saccharometer. (From Wood.)

filled with normal urine for comparison. A small piece of fresh yeast is mixed thoroughly with a definite quantity of the suspected urine measured in a marked test-tube that comes with the apparatus. The mixture is then poured carefully into the graduated tube, care being taken to expel all the air by slanting the tube so that bubbles escape. The tubes are allowed to stand at a temperature of about 86° F. until fermentation has ceased, i. e., for about twenty-four hours. The CO_2 resulting from fermentation collects at the top of the tube, and the percentage of sugar is read off at the level of the fluid. If the second tube also shows a small amount of gas, this is deducted.

The above are the principal tests for sugar employed in clinical work. For the other methods, the reader is referred to the larger handbooks.

Other Carbohydrates

Three other carbohydrates are sometimes found in the urine, but are of very slight clinical importance. They are *lactose* or milk sugar, *lævulose* or fruit sugar, and *inosite*, or muscle sugar. The isolation of these requires elaborate apparatus, and the use of the polariscope. Lactose, however, gives the phenyl-hydrazin test, forming yellow needles grouped in clusters.

Urea and its Compounds

Urea

The most important element in the urine is urea, representing, as it does, the last term in the series of oxidized nitrogenous bodies. Its source is twofold: from the tissue waste and from ingested food. The greater part of nitrogen in food appears in the urine in the form of urea, which ranges from three hundred to six hundred grains in twenty-four hours (20–40 grams or 1.5 to 2.5 per cent). The average daily amount of urea for a healthy man on a mixed diet with moderate exercise may be estimated as 33.8 grams, which gives about 0.015 to 0.035 grams per hour for each kilogram of body weight. Women and children excrete a less quantity of urea than men, but relatively more per pound of body weight. The normal standard urea excretion generally accepted in clinical work is two per cent, or twenty grams per liter, or ten grains to the ounce.

The organs chiefly concerned in the production of urea are the liver and the spleen, but lymph nodes probably assist to a slight extent. The maximum quantity of urea occurs with meat diet and the minimum with a vegetable diet. Changes in the daily amount of excreted urea correspond so closely to the destruction of tissue and the assimilation of proteids that they form a valuable index of bodily health. In fevers and inflammations, in the waking state and under intense muscular or mental work, urea is markedly increased in the daily amount eliminated; in liver and kidney disease, in several of the cachexias, it is diminished.

Quantitative Estimation of Urea.—There are many elaborate methods for accurately ascertaining the amount of urea. The most available method in the clinical laboratory is the one that is based on the fact that urea is decomposed into carbon dioxid and nitrogen in the presence of sodium hypobromite.

The reagents are most conveniently kept and applied in the form of Rice's solutions: (1) caustic soda 100 grams, distilled water 250 grams; (2) bromin 30 grams, potassium bromid 30 grams, water 240 grams.

The test is made in Doremus's ureometer, or in one of the numerous modifications of it.

Doremus's Ureometer (Figs. 84 and 85).—This apparatus consists of a bulb with an upright graduated tube and a small nipple pipette, holding 1 c.c. of urine. The graduations read in fractions of a gram of urea per c.c. of urine, or else

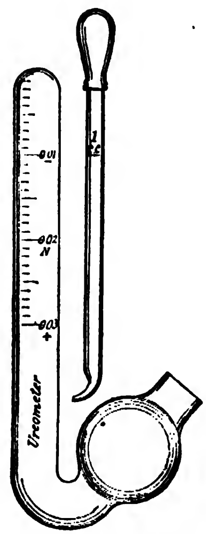


Fig. 84.—Doremus Ureometer.

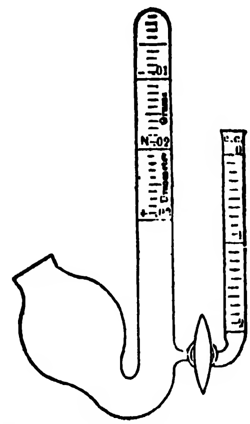


Fig. 85.—Doremus Ureometer, Improved Form. (From Wood.)

show the number of grains of urea per fluid ounce of urine. The bulb is filled with the hypobromite solution (one of the formulæ given above), and the tube is inclined so as to remove the last air bubble from its closed part. One c.c. of urine is then taken with the pipette, and the point of the latter is introduced into the bend of the tube. The nipple is slowly and gently compressed, care being taken to expel all the urine, but not to drive any air out of the nipple. The pipette should be dried before being introduced, and should be filled accurately. The sodium hypobromite in the solution comes into contact with the urea of the urine, which is decomposed into nitrogen, carbon dioxid and water. The amount of nitrogen disengaged is a measure of the urea, and 1 c.c. of nitrogen at standard temperature and pressure equals 0.0027 grams of urea. The gas is, therefore, allowed to escape into the top of the tube and the level of the fluid to sink until no more bubbles escape. This takes ten or fifteen minutes or sometimes longer. The percentage of urea is then simply read on the graduated tube.

Uric Acid

Uric acid is a nitrogenous compound occurring in the urine in daily amounts from 0.4 to 0.8 grams. It is formed in the body by the decomposition of the nucleins of the nuclei of the cells of both food and tissues. It is freely soluble

in water, especially with heat, and is still more soluble in solutions of urea. It does not occur often as free uric acid, but usually is combined with sodium, potassium and ammonium to form urates. When a strong acid is added to a urine containing the neutral salts of uric acid which are soluble, a deposit of insoluble acid urates occurs. Uric acid crystallizes in the urine in rectangular prisms, in wedges, whetstone shapes and rosettes of a yellowish-red color.

Qualitative Tests for Uric Acid.—Qualitative tests for uric acid are of no clinical value. The following three tests may be used in recognizing the acid.

No. 1. Put a drop of urine on a slide, add a drop of nitric acid, warm over a spirit lamp. After evaporation the characteristic crystals of urea nitrate will be discovered by the microscope.

No. 2. Put a few drops of urine in a test-tube, add an equal amount of solution of sodium hypobromite. If urea is present there will be a rapid formation of bubbles.

No. 3. Warm a few crystals of urea in a test-tube, add a trace of sodium hydrate, and then a drop of a dilute solution of cupric sulphate. A violet or rose color will develop in the presence of urea: this is called the biuret reaction.

Quantitative Estimation of Uric Acid.—There is no accurate method of estimating uric acid which is sufficiently convenient for clinical purposes. The following methods are described because they are less troublesome than any other devised:

HEINTZ'S METHOD.—Add 10 c.c. hydrochloric acid to 200 c.c. urine and let it stand twenty-four hours in a cool place. Weigh a filter and collect the deposited crystals upon it, washing with cold distilled water. Dry the filter thoroughly and weigh. Subtract the weight of the filter alone and obtain the weight of the uric acid in 200 c.c. of urine; from this may be determined the amount in the total daily urine. Always filter the urine before using this method.

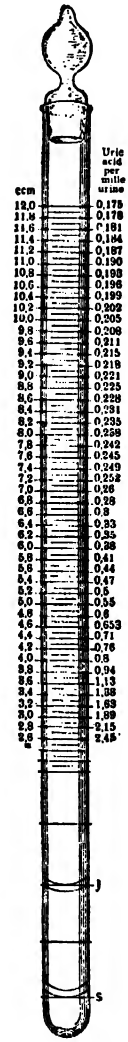


FIG. 86.—RUHEMANN'S URICOMETER FOR THE RAPID ESTIMATION OF URIC ACID.

RUHEMANN'S URICOMETER is recommended for the rapid estimation of uric acid (Fig. 86). The lowest mark (S) shows the height to which the indicator (carbon disulphid) should reach. Then follows to the mark I, a space of 2 c.c. content into which iodin solution is poured. This solution is composed of iodin, 1.5; potassium iodid, 1.5; alcohol, 15.0; water, 185.0. Above the mark I, at 2.6,

begins an empiric scale which, at distances of 0.2 c.c., gives the uric acid value *pro mille*. After the carbon sulphid and iodin solution have been placed in the burette, the urine is slowly added and the mixture strongly shaken after each addition. The urine is added until the primary brown color gives place to a white one, at which moment the percentage of uric acid is read off at the top of the column of fluid. If the urine contains less uric acid than the apparatus will indicate, add the iodin only to the mark midway between 1 and S and read *half* values. Alkaline urines should be acidulated with acetic acid, and, if abundant sediment of sodium urate is present, the specimen should first be well shaken. Traces of sugar and albumin do not interfere, but if large amounts of pus or blood are present, these should be removed by heat and filtration. The procedure requires about from thirty to forty-five minutes.

Urates

Nearly all the uric acid in the urine exists in the form of urates, i. e., salts of potassium, sodium, ammonium, calcium and magnesium. These salts are soluble at body temperature, but a large part of them precipitate on cooling the urine.

Two kinds of urates are found: the acid and neutral urates. The acid salts are less soluble and are more readily precipitated. When the neutral urates are in excess, they often remain dissolved for some time and precipitate only when the urine turns more intensely acid. (See Acid Fermentation.) The addition of acid to such urines also makes the urates insoluble and precipitates them, as they are converted into acid urates. On heating, the precipitate of urates is dispelled. Urates usually precipitate in the form of amorphous granules, which may be mixed with uric-acid crystals if the urine has been allowed to stand.

Hippuric Acid

Hippuric acid exists normally in quantity from 0.5 to 1.0 gram and is increased by vegetable and fruit diets, by certain drugs like benzoic acid, and in some diseases, like chorea, diabetes, and acute fevers.

Diacetic Acid

Diacetic acid occurs in the urine in the advanced stages of diabetes. It is usually a grave symptom, giving warning of approaching coma and death.

Acetone

Acetone is a colorless, thin, watery fluid of a fruity odor, occurring in the urine and blood in diabetes and malignant tumors; also at times in high fever,

PLATE I

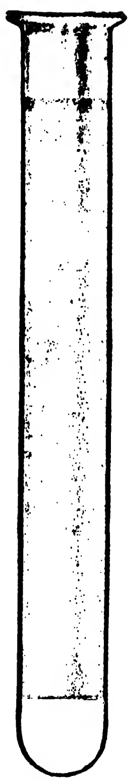


Fig. 1.
Normal Urine.

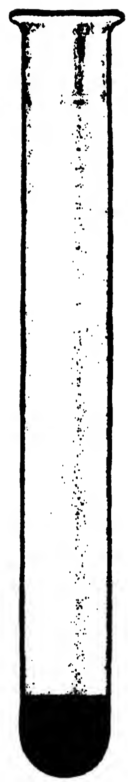


Fig. 2.
Simple Indicanuria.

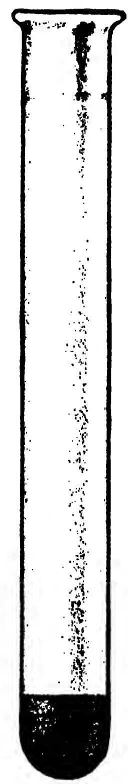


Fig. 3.
Potassium Iodid Reaction.

INDICAN COLOR REACTION IN URINE. (After W. H. Porter.)

smallpox, typhus fever, scarlet fever, measles and Bright's disease. In diabetes, acetone very often precedes a dangerous diaceturia.

Acetone can readily be detected by Lieben's iodoform test:

Lieben's Test

1. Distil the urine.

2. Add Gram's solution to the distillate and then some sodium hydrate. If acetone is present in any quantity, iodoform is immediately precipitated. If present in small quantities, then iodoform crystals should be looked for microscopically.

Indican and other Ethereal Sulphates

The ethereal sulphates in the urine constitute a group of substances, products of intestinal decomposition, which are sulphates of sodium and potassium, combined with an organic radical, such as iodoxol or a phenol.

Indican is the most important of this group of sulphates. It is derived from indol, a product of intestinal putrefaction of proteids. Indol is absorbed from the intestine, is oxidized to indoxyl, and combines with potassium (and also partly with sodium) sulphate, forming indican, which is eliminated in the urine.

Increased intestinal putrefaction increases the amount of indican eliminated by the kidneys, thus acting as a renal irritant and frequently giving rise to albumin and casts in the urine to such a degree that many cases of indicanuria have been diagnosticated as Bright's disease.

Indicanuria is marked in all cases in which intestinal digestion is disturbed, such as: typhoid fever, cholera, acute and chronic enteritis, acute and chronic gastritis, dyspepsia, appendicitis, peritonitis, acute cancer of the peritoneum, diseases of the liver and pancreas, chronic constipation.

Indican itself is a colorless or brown sirup, soluble in water and has a bitter taste. It can be turned into indigo blue by adding acids and heating.

Test for Indican.—To equal parts, about 10 c.c. each, of concentrated hydrochloric acid and fresh urine, add two or three drops of one-half-per-cent watery solution of potassium permanganate and then invert the tube several times. After one or two minutes, add enough chloroform to make a sediment about three quarters of an inch and shake well. If indican is present, the chloroform becomes blue.

Phenol and *skatol* are also products of intestinal putrefaction, the latter forming low down in the tract. They are absorbed from the intestine into the blood and from there into the kidneys, the same as indican.

Bile Pigment

The presence of biliary pigments, bilin, and biliverdin, indicates derangement of the liver or biliary tract. They are always formed in the urine in jaundice, due to obstruction of the common duct and after an attack of hepatic colic. Biliary pigments impart a greenish-yellow color to the urine and the foam produced by shaking the specimen vigorously has a yellow tint.

Gmelin's Test.—A modification of Heller's albumin test, known as Gmelin's test, is commonly used to demonstrate the presence of these pigments in the urine.

In a test-tube the urine is carefully deposited on top of a small quantity of fuming nitric acid, to which has been added yellow nitrous acid. A greenish ring appears at the point of contact if the urine contains bilin or biliverdin. There are several modifications of this test. A drop of the same acid on the white filter paper, through which the specimen has been filtered, will give a similar reaction.

Iodin Test for Bile.—A solution of one part of tincture of iodin (or Lugol's solution) to nine parts of water, overlaid on the urine in a test-tube, produces a distinct green color at the point of contact of the urine and reagent if bile is present.

Hemoglobinuria

Hemoglobinuria, or the presence of hemoglobin, the coloring matter of blood in solution in the urine, is of rare occurrence. Under normal circumstances, hemoglobin is a constituent part of the red blood corpuscles and is not found in the urine separate from them.

Hemoglobinuria has been found with more or less frequency in severe types of infectious diseases, especially yellow fever, scarlet fever; also in purpura, scurvy and malaria. It occurs also in severe burns and in poisoning by coal-tar phenol derivatives, carbolic acid and naphthol.

Heller's Test for Hematin.—By adding a little caustic-potash solution and gently heating the urine, the earthy phosphates are precipitated. The precipitate carries the blood-coloring matters with it as it sinks and is stained red. If the urine is alkaline, the phosphates can be precipitated by adding a few drops of magnesium fluid and heating gently. (See page 91.)

Test for Hemin Crystals.—The precipitated earthy phosphates are filtered and placed on an object glass and warmed until completely dry. Add a minute granule of common salt and mix thoroughly, cover with a thin cover glass and then allow a drop or two of glacial acetic acid to pass underneath the cover glass. The slide is carefully warmed until bubbles make their appearance. After cooling, hemin crystals can be seen by the aid of the microscope.

Melanin

Melanin is a pigment found in cases of melanotic cancer or sarcoma, and occurs either in solution in the urine, or is deposited in small black particles. Melanin also occurs rarely in severe wasting conditions and in chronic malaria.

To detect melanin, add bromin water to the urine, which causes a yellow precipitate that gradually blackens. On adding ferric chlorid, the urine turns gray; if enough be added, the phosphates will precipitate, carrying the coloring matter with them. The urine containing melanin is normal in appearance when freshly voided, but on exposure to the air becomes brown or black.

Organic Constituents of Minor Importance

Leucin and tyrosin are found in the urine, chiefly in destructive diseases of the liver (acute yellow atrophy, phosphorous poisoning) and in acute infections (smallpox, typhus).

Leucin and tyrosin usually occur together; they may be deposited in the sediment when present in large amounts. Usually the urine contains an excess of bile and a deficiency of urea.

The crystals may be obtained by evaporating the urine and, if the crystals are extracted with alcohol, leucin dissolves and tyrosin is left.

Inorganic Constituents

The principal inorganic constituents of the urine are the chlorids, phosphates and sulphates occurring in combination with sodium, potassium, ammonium, calcium and magnesium. The total amount of inorganic substances excreted in twenty-four hours varies between nine and twenty-five grams.

Chlorids

The chlorids rank next to urea in importance among the solid constituents of the urine. The greater part of the chlorids exist as sodium chlorid, while smaller amounts of potassium and ammonium chlorids are found. The chlorids in the urine are derived from the food, and most of the salt ingested is eliminated in the urine as such.

The normal amount of chlorids excreted in twenty-four hours varies from ten to twenty grams, but if much salt is taken with the food, the amount may reach fifty grams. Chlorids are diminished especially in all acute affections, in which there is a serous exudation or transudation, vomiting, or diarrhea. Chlorids are diminished or absent also in cholera, septicemia, pyemia, puerperal fever, and acute articular rheumatism. The chlorids may be absent in

the urine in a chronic disease, if accompanied by dropsy (chronic nephritis, heart disease), and as the dropsy is absorbed, the chlorids gradually are increased. In pneumonia, the chlorids are low or absent in the acute stage, but as the exudate becomes absorbed, they increase, and may become normal. In meningitis (acute) the chlorids are also increased, so that by testing for them, we may differentiate between meningitis and typhoid. In nephritis, the amount of chlorids eliminated as compared to the amount of urea, is of considerable importance.

Detection and Approximate Estimation.—Silver Nitrate Test.—Before applying this test, if more than a trace of albumin is present, it should be removed by heat, as albuminate of silver forms and interferes with the reaction. One half ounce of urine is laid upon an equal amount of pure nitric acid in the same manner as in the test for albumin. Then one drop of a 1 : 8 solution of silver nitrate in water is added. A precipitate of silver chlorid is formed, which, if normal or increased in amount, appears as a compact, solid mass which falls to the surface of the nitric acid. If the amount is diminished, the silver chlorid becomes more or less diffused through the layer of urine.

Carbonates

Minute quantities of carbonates and bicarbonates of sodium, ammonium, calcium, and magnesium, are found in fresh urine of alkaline reaction. Ammonium carbonate may occur in large amounts, owing to alkaline decomposition. The carbonates in urine are derived from the food, especially from vegetable acids, such as lactic, tartaric, malic, succinic, etc. They are, therefore, most abundant in the urine of herbivora. An excess of carbonates renders the urine turbid when passed or on standing and, as a rule, the sediment is mixed with phosphates.

Detection.—On the addition of an acid, the presence of carbonates is detected by the evolution of gas bubbles, and this gas, when passed into baryta water, renders the latter turbid. The determination of the amount of carbonic acid will be found described in the larger text-books.

Phosphates

Earthy Phosphates.—Render half a test-tubeful of filtered urine alkaline with ammonia and warm gently. Earthy phosphates, in the form of a whitish cloud, settle to the bottom of the tube. The precipitate is dissolved by the addition of acetic acid.

Approximate Quantitative Estimation (*Ultzmann*).—A test-tube 2 cm. wide is filled with urine to the depth of 5¾ cm., and a few drops of strong ammonia are added. The mixture is warmed over an alcohol lamp until the earthy phosphates separate. The depth of the sediment is measured after

standing for fifteen minutes. Normally, the layer will be 1 cm. high: a greater depth indicates an increase, while a less abundant precipitate means diminution.

Alkaline Phosphates.—After the earthy phosphates have been separated, as shown above, the mixture is filtered. To the filtrate is added one third of its volume of magnesium fluid (magnesium sulphate, ammonium hydrate, ammonium chlorid, of each one part; water eight parts). The white precipitate consists of alkaline phosphates. To make this test available for approximate estimation, according to Ultzmann, 10 c.c. of the urine are treated with 3 c.c. of the magnesium fluid. A precipitate of crystalline ammonio-magnesium phosphate is found, together with an amorphous mass of calcium phosphate. If a milky turbidity permeates the entire fluid, the alkaline phosphates are normal in amount. If an abundant precipitate gives the fluid the appearance of cream, they are greatly increased; and if a slight turbidity follows, or if the fluid remains transparent, they are decreased.

Sulphates

The ethereal sulphates have already been considered. There are in addition in the urine the ordinary alkaline sulphate of sodium and potassium, the sodium salt being present in larger quantities. The amount of sulphates excreted by healthy adults ranges from 1.5 to 5.0 grams daily. About one tenth of this amount is represented by the ethereal sulphates, about nine tenths represented by the potassium and sodium salts.

The sulphates in the urine are derived partly from food and partly from the decomposition of proteid substances in the tissues. The sulphur from the foodstuffs and from the tissue elements is oxidized to sulphuric acid, the latter in turn combining with sodium and potassium to form a sulphate of these bases. The amount of sulphates in the urine is increased after taking sulphuric acid or sulphates; after active exercise; after the inhalation of oxygen; in acute fever, in meningitis and in rheumatism. As a rule, the amount of sulphates is parallel to that of urea. Sulphates are decreased in most chronic diseases when metabolism and appetite are diminished; also after carbolic-acid poisoning or after the use of large doses of salol, etc. In such cases the ethereal sulphates are increased.

Detection.—For ordinary purposes, the following test is sufficient: To a test-tube one half full of filtered urine, add one or two inches of barium solution (barium chlorid, 4 parts; concentrated hydrochloric acid, 1 part; distilled water, 16 parts). A white precipitate occurs which normally fills one half the concavity of the test-tube. A larger amount indicates an increase, a smaller amount a decrease.

IV. MICROSCOPICAL EXAMINATION

General Considerations

To obtain the sediment of a specimen of urine for microscopical examination, we can use either the old-fashioned gravitation method or the centrifuge. If the former is used, the specimen must be allowed to stand in a well-covered, conical glass, preferably in a cool, dark place, from six to twelve hours. This method has the obvious disadvantages of delay in examination and more or less disintegration of the organic elements.

Centrifugal sedimentation permits the immediate examination of the urine microscopically and produces a concentrated sediment from freshly voided urine before cells and casts can be destroyed by the alkalinity of the standing urine and before the development of bacteria. This is the only method by which crystals, formed in the urine before it is passed, can be distinguished from those formed afterwards. By the old methods in urine of high specific gravity, the lighter forms of casts might float and thus be overlooked. This does not happen with the centrifuge.

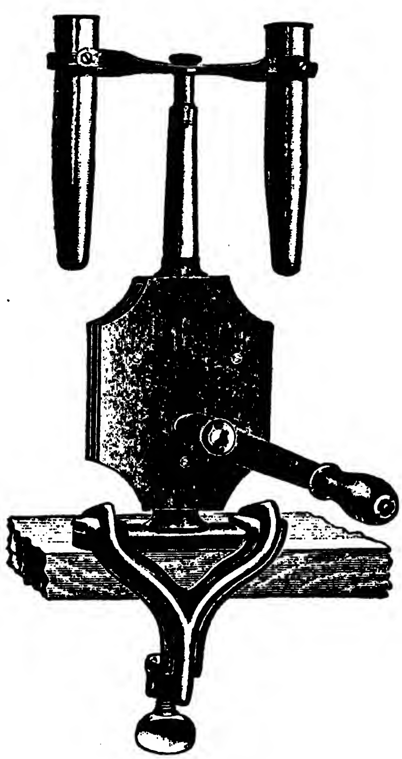


Fig. 87.—Hand Centrifuge. (From Kny-Scheerer.)

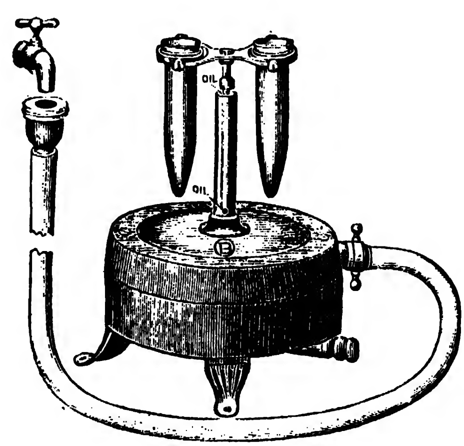


Fig. 88.—Water Centrifuge.

The Centrifuge.—Three types of centrifuge are on the market: the hand (Fig. 87), water motor (Fig. 88), and the electric centrifuge (Fig. 89). Of the three, the *hand centrifuge* is the least expensive and answers the purpose

where it is impossible or impracticable to use either a water or electric centrifuge. The labor and time required in using it, owing to the limited speed obtainable, are obvious disadvantages.

The *water motor* is in many ways the most practical. It can be used wherever there is a faucet of running water under ordinary city pressure and it is so simple that it never gets out of order.

The *electric* centrifuge has some advantages, and is preferred by laboratory workers on account of the greater speed obtainable. It can be run with ordinary incandescent lighting currents of 110 volts, direct or alternating, or even by currents of less voltage.

Aluminum shields protect the tubes from all danger of breaking, no matter what the speed may be. The tubes have conical tips in which the sediment collects, and it is not disturbed by sudden stopping of the instrument or by decanting the urine.

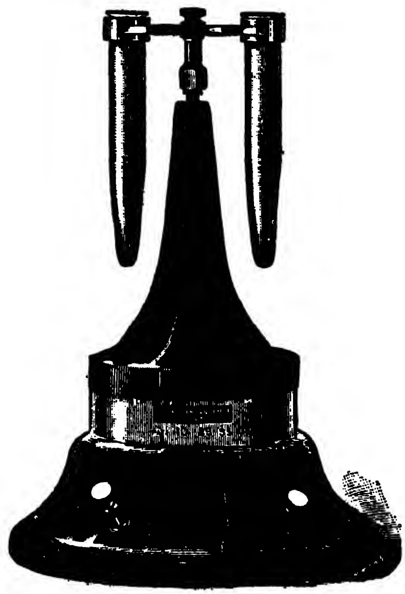


Fig. 89.—The Purdy Electric Centrifuge.

Methods of Examining the Sediment

A pipette, consisting of a single glass tube, drawn to a moderate point, is held with its upper opening tightly closed with the index finger and dipped to the bottom of the sediment glass of the centrifuge tube. The finger is then released and the sediment is allowed to rush in from below upward. A specimen should include portions of all strata of the sediment, mixed with a little urine, especially if the sediment is very dense.

The sediment is dropped upon a slide and covered with a large cover glass. The excess of urine is taken up with filter paper. When the low power (only $\frac{2}{3}$ objective) is used, no cover glass is needed, but for the high-power lens a cover glass is essential to prevent soiling the lens, the microscope and the examiner's fingers.

It is best to go over a slide with the low-power lens (Leitz No. 3, Zeiss AA, Bausch & Lomb $\frac{2}{3}$). With this, most of the larger elements can be made out. For the fine study of epithelia, casts, etc., however, the higher power (Leitz No. 6, Zeiss D, Bausch & Lomb $\frac{1}{6}$) is necessary. For the routine examination of a large number of specimens without a cover glass, the lower power with a stronger eyepiece (Zeiss No. 12, Achromatic or Leitz No. 3, Ocular 5) will be found sufficient. In fact this combination offers a rapid, cleanly way of ex-

amining urine, which will appeal to the busy practitioner. For differentiating epithelia and the finer structures, however, it cannot serve in all instances.

In searching for casts, especially of the hyaline variety, the diaphragm of the microscope should be closed so as to admit the least possible amount of light. The micrometer screw of the microscope should be freely used in looking for casts, as these structures are cylindric and often so trocated that one turn of the screw brings one part into view, while the rest remains hazy. The flat mirror should be used when looking for casts. The Abbé condenser should not be used when looking at urinary sediment.

Unorganized Sediment

Uric-Acid Calculi.—In uric-acid calculi in the kidneys or elsewhere in the urinary tract, considerable masses of uric-acid crystals, with jagged outlines, may be found in the urine.

Detection.—Uric-acid crystals (Figs. 90, 91, 92) vary greatly in shape, but the typical forms are the rhombic, or six-sided plates, the whetstone shape

Fig. 90.—Crystals of Uric Acid. (From Wood.)

in stellate groups and crystals resembling a comb with teeth on both sides. All these are more or less yellow in color, though occasionally some of them appear colorless. They dissolve on adding a few drops of alkali and reappear on adding acetic acid.

Urates.—The mixed sodium, potassium, ammonium, calcium and magnesium urate deposit is a granular sediment of a reddish color, varying from pink to brick-red, and usually sinks quickly, though it may make the urine turbid. The precipitate redissolves on gently heating the urine.

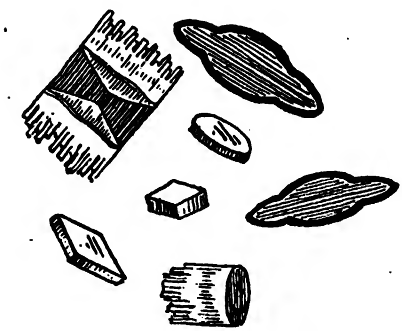


FIG. 91.—UNUSUAL FORMS OF URIC ACID.

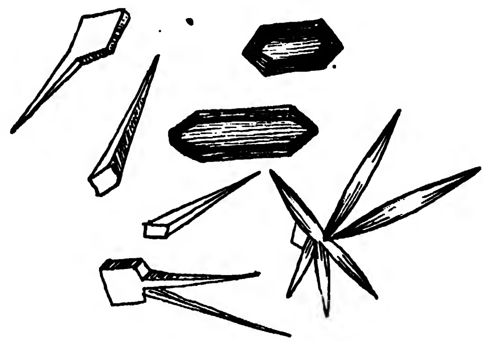


FIG. 92.—UNUSUAL FORMS OF URIC ACID.

SODIUM URATE.—This forms the greater bulk of the mixed urate deposit, and is usually amorphous. It is generally found in mosslike masses of minute granules which easily adhere to larger masses of sediment. When crystalline, it is seen in the form of fan-shaped groups, pointed at the center, or arranged like sheaves of wheat. These crystals show characteristic striation.

POTASSIUM URATE.—This occurs always as an amorphous sediment, forming a part of the mixed urate deposit. It is soluble in hot water, insoluble in cold water.

CALCIUM URATE.—It is a rare deposit and is found as a part of the amorphous mixed urate sediment.

AMMONIUM URATE.—It is said by some that this is in reality sodium urate in modified form, marking a transition of an acid sediment into an alkaline. Ammonium urate is characteristic of alkaline fermentation, and is usually associated with triple phosphate and calcium phosphate. It occurs in the form of yellowish-red or dark-brown spherules, studded with fine sharp thorns which have given rise to the term "thorn-apple" crystals (Fig. 93).

FIG. 93. — CRYSTALS OF AMMONIUM URATES. (From Wood.)

These crystals may be massed in clumps or chains and are soluble in hot water or in acids; they emit the odor of ammonia on adding alkalies. It is the only urate found in alkaline urine.

Calcium Oxalate.—Normally the greatest part of the oxalic acid taken in the food is converted by oxidation into urea and carbonic acid. When for some reason (disease) this oxidation is interfered with, this change does not take place, then the oxalic acid is excreted as such in combination with calcium (from the blood, also derived from food and tissues).

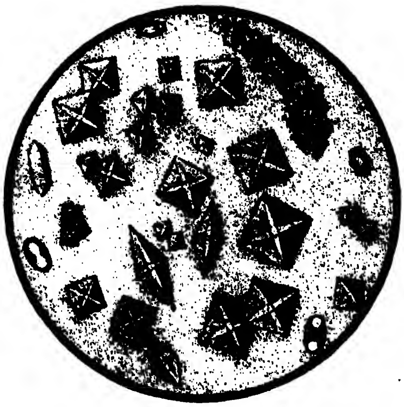


Fig. 94.—Calcium Oxalate Crystals (After Jacob.)

Detection.—The crystals of calcium oxalate may be found in acid urine when they may accompany crystals of uric acid, or in alkaline urine when they accompany triple phosphates. Two typical forms of calcium oxalate crystals are distinguished (Fig. 94).

The octahedral crystals consist of two four-sided pyramids placed base to base and appear like squares crossed like envelopes, or, if turned with their long axes toward the observer, like long-

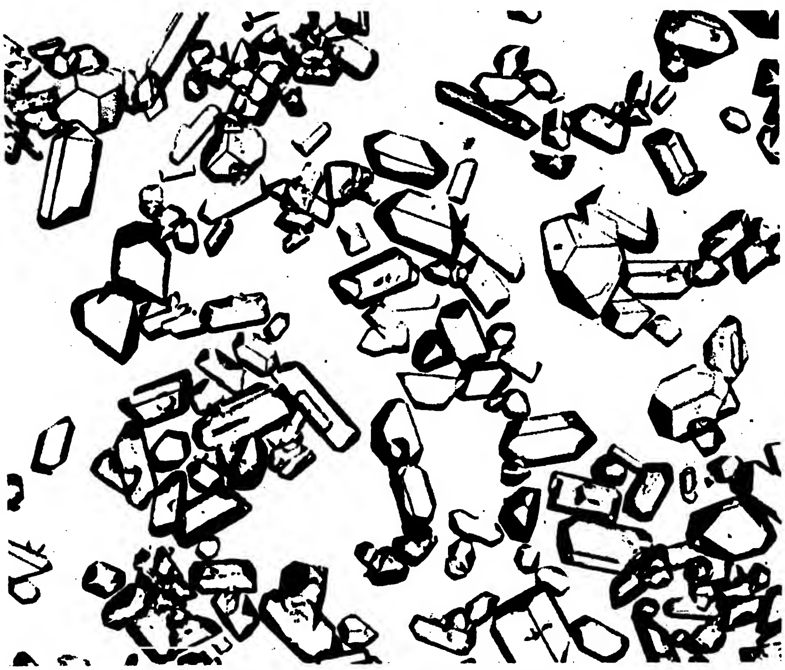


Fig. 95.—Crystals of Ammonium Magnesium Phosphate. (From Wood.)

pointed octahedra. Sometimes these crystals coalesce with larger masses. The dumb-bell crystals are not so common and look like two crossed dumb-bells. They must be distinguished from the yellow or brown dumb-bells of uric acid.

The dumb-bells of calcium oxalate are soluble in hydrochloric acid, those of uric acid in alkalies.

Phosphates.—In the sediment the earthy phosphates are represented by calcium phosphate and by ammonio-magnesia phosphate (triple phosphate, so called). The alkaline phosphates are not represented in the sediment.

FIG. 96.—FEATHERY FORM OF TRIPLE PHOSPHATES.

CALCIUM PHOSPHATE.—Calcium phosphate is either amorphous (the normal salt), or crystalline (the acid salt), the latter consisting partly of magnesium phosphate. The amorphous form occurs in feebly acid urines and is seen in small, highly refractive granules, in clumps or adhering to other parts of the sediment. The crystalline form is found in urine about to undergo alkaline fermentation, but which is still weakly acid. They are prismatic and arranged in either single or in star-shaped, often in fanlike, groups. Acetic acid rapidly dissolves them, whereas it slowly affects sodium-urate crystals similarly shaped.

TRIPLE PHOSPHATE CRYSTALS.—Ammonio-magnesium phosphate occurs either as the coffin-lid crystals or the feathery crystals. The former is more common and consists of a triangular prism with one of the three angles wanting.

They are large in size and at times shortened into squares which may be mistaken for calcium oxalate. The stellate crystals are feathery stars or parts of stars. The phosphate crystals are soluble in acetic acid, while the oxalate crystals are insoluble in this acid.

Carbonates and Sulphates.—(*a*) CALCIUM CARBONATE.—Calcium carbonate is found rarely in the urine of man, but in large quantities in the urine of some lower animals. It occurs in the form of small squares. On adding acetic acid, an effervescence of carbon dioxid results.

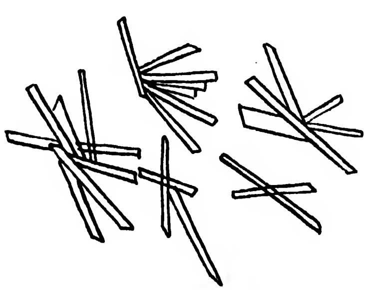


FIG. 97.—CRYSTALS OF CALCIUM SULPHATE.

(*b*) CALCIUM SULPHATE.—Calcium sulphate is a very rare deposit; it occurs in highly acid urine with high specific gravity, in the form of needlelike prisms which often are grouped in radiating fanlike arrangements (Fig. 97).

Leucin and Tyrosin.—(*a*) LEUCIN occurs in the form of yellowish, highly refractive spheres, looking like oil drops (Fig. 98), which show radiating or concentric stripes. They are often arranged in masses or groups of three or more

spheres. Unlike oil, leucin is not soluble in ether, but is soluble in alkalies. They are larger than the spheres of ammonium urate and have no spikes.

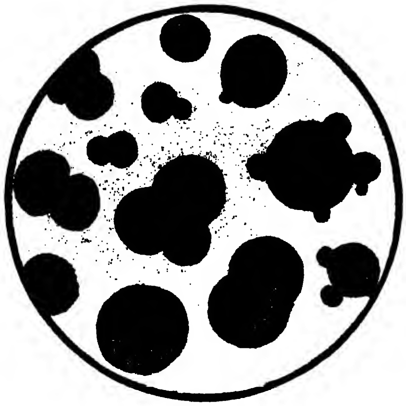


FIG. 98.—LEUCIN CRYSTALS. (From Jacob.)

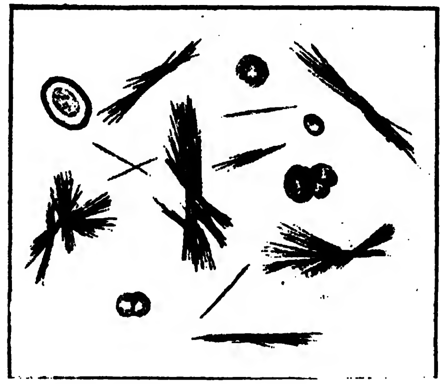


FIG. 99.—LEUCIN AND TYROSIN CRYSTALS. (From Wood.)

(*b*) TYROSIN occurs as very fine needles arranged in sheaves or rosettes (Fig. 99). They are colorless, but when arranged in masses, they appear quite dark. They are insoluble in ether, but soluble in alkalies.

Blood and Bile Pigments; Fat; Cholesterin.—(*a*) BILIRUBIN.—In urine containing bile, bilirubin may be found as amorphous masses, or as needles in stellate formations, often adherent to cells, or in yellow or ruby-red rhombic plates. They show a green rim on adding nitric acid.

(*b*) HEMATOIDIN.—Crystals of hematoidin occur in urine containing blood, e. g., after an extensive hemorrhage, in pyonephrosis, renal stone, etc. The crystals are identical with those of bilirubin and probably hematoidin is identical with the former.

(*c*) FAT GLOBULES.—Fat globules may be seen in the urine as extraneous matter from unclean bottles, or from ointments in the genitals. When enough fat is present to be seen with the naked eye, the term "lipuria" is used. When the fat makes the urine milky, the term "chyluria" is used. The latter is usually due to the presence of a parasite, the Filaria sanguinis.

Fat in small amounts may occur in healthy urine after a fatty diet, also in pregnancy and in phosphorous poisoning. Many minute fat globules are found in the urine of chronic nephritis in which the fat granules are derived from disintegrated fatty epithelia. They are found also in other chronic inflammations, such as cystitis, pyelitis, prostatitis, urethritis and vaginitis, in cystic kidney, and in abscesses opening into the ureter.

(*d*) CHOLESTERIN.—Cholesterin is a monatomic alcohol, normally present in the blood, the nerve tissues, the bile, etc. It occurs in gall-stones, in pus, tumors, etc., but is a rare deposit in the urine in extensive fatty changes in the kidney as a result of acute or subacute or chronic nephritis. Still more rarely

it occurs in cheesy degeneration of cystic kidneys. It crystallizes in large plates, is insoluble in water, but soluble in alcohol, ether, chloroform, etc. If a mixture of five parts of sulphuric acid is allowed to act on a cholesterin plate, a bright carmine-red color appears, which changes to violet.

Cystin.—Cystin is seldom found as a urinary sediment and probably never in normal conditions. Its origin in the economy is not clearly understood, but the liver is regarded as the seat of its formation. It is a crystalline compound and occurs in two forms; either as hexagonal tablets with an opalescent luster, or as four-sided prisms. It is soluble in caustic alkalies, oxalic and strong mineral acids, insoluble in boiling water, acetic acid, ether and alcohol. These crystals may be distinguished from uric acid by treating them with strong acid—which dissolves them but not uric acid—and from triple phosphates by the solubility of the latter in acetic acid (Fig. 100).

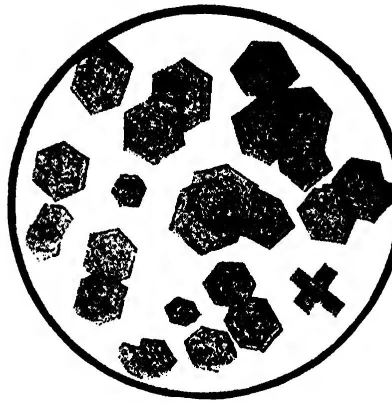


Fig. 100.—Crystals of Cystin. (From Jacob.)

Clinical Significance.—But little is known as yet of the interpretation of cystin in the urine. It is found in typhoid fever, in renal degeneration, in chlorosis, and acute rheumatism. It occasionally forms calculi.

Organized Sediments

1. **Blood Cells.**—As a urinary sediment, blood cells are always pathological. Their form depends upon the source of the bleeding and the reaction of the urine; when the typical biconcave disks are preserved, it is easy to recognize them by the microscope and in acid urine they retain their shape for a long time, gradually shriveling and becoming crenated (Fig. 101). They seldom form rolls as when drawn from a blood vessel, except in cases of great hemorrhage from bladder or urethra. If the urine be concentrated, the biconcave form is exaggerated and the corpuscles shrink and become crenated; when the urine is of low specific gravity, they swell and may become spherical.

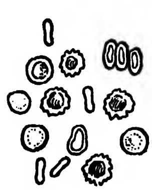


Fig. 101.—Blood Cells in the Urine.

2. **Pus.**—Pus cells may be derived from any part of the urinary tract. The urine containing pus is usually turbid and gives the albumin reactions. Under the microscope, the pus cells appear as circular, pale, finely granular disks, about twice the size of the red blood cell; they contain distinct nuclei, often two or three (Fig. 102). Water swells the pus cell, renders it paler and ob-

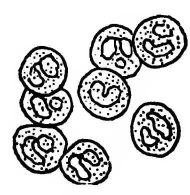


Fig. 102.—Pus Cells in the Urine.

scures its outlines; acetic acid produces the same effect, more quickly, and, causing the granular condition to disappear, renders the nuclei very distinct. Pus cells resemble the white cells of the blood and lymph, and in the fresh state present the glistening appearance of living protoplasm and also ameboid movements; seen in the urinary sediment, the cells are dead.

The chief constituent of pus cells are albuminous bodies; especially nucleoalbumin, which is insoluble in water, but expands into a tough slimy mass when treated by sodium-chlorid solution. Pus in the urine is usually accompanied by tissue elements or bacteria, which aid materially in determining its anatomical and pathological source.

3. **Epithelia.**—In normal urine, a few epithelial cells from the superficial layers of the urinary tract are always seen and have no special significance. When these cells are altered by disease and are found in considerable numbers, accompanied by pus or red blood cells, a pathological process exists in some part of the genito-urinary tract.

Theoretically, each separate portion of the urinary tract has a type of epithelium peculiarly its own, but in actual practice there are so many transitional forms in every portion of the tract, that it is not always possible to specify the origin of a given cell. Inasmuch, however, as the recognition of the different characteristic epithelia is absolutely essential to a localization of diseases of the tract by urinary examination, the problem of distinguishing the epithelia of each portion of the tract is of great importance.

Most authorities maintain that, while histologic preparations of the different urinary organs show that the epithelial lining of each has well-marked characteristics, the epithelia shed by these organs during life and appearing in the urine are radically altered in aspect, and their characteristics to a large extent obliterated. Moreover, the same school of clinical pathologists holds that the cells of the deeper layers of the bladder, for example, are identical in appearance with cells from other parts of the urinary tract.

The chief characteristics of epithelia found in the urine are their form and size. By comparing the size of the different epithelia with that of the leucocyte or pus cell, we have, because the latter varies so little, a fair idea of the relative magnitude of the epithelial structures.

Three chief types of epithelia occur in the urine, viz., the flat or squamous, the round or cuboidal, and the columnar or caudate. All these epithelia have one or more distinct nuclei, and are more or less granular. When the epithelia in the urinary tract are stratified, the outer layers are usually flat, the middle layers cuboidal, the inner columnar.

The tubules of the kidney, the prostatic acini and ducts, and the ejaculatory ducts are lined with a single layer of cuboidal or columnar epithelium. The pelvis of the kidney, the ureters, the bladder, the urethra and the vagina are lined with stratified epithelia.

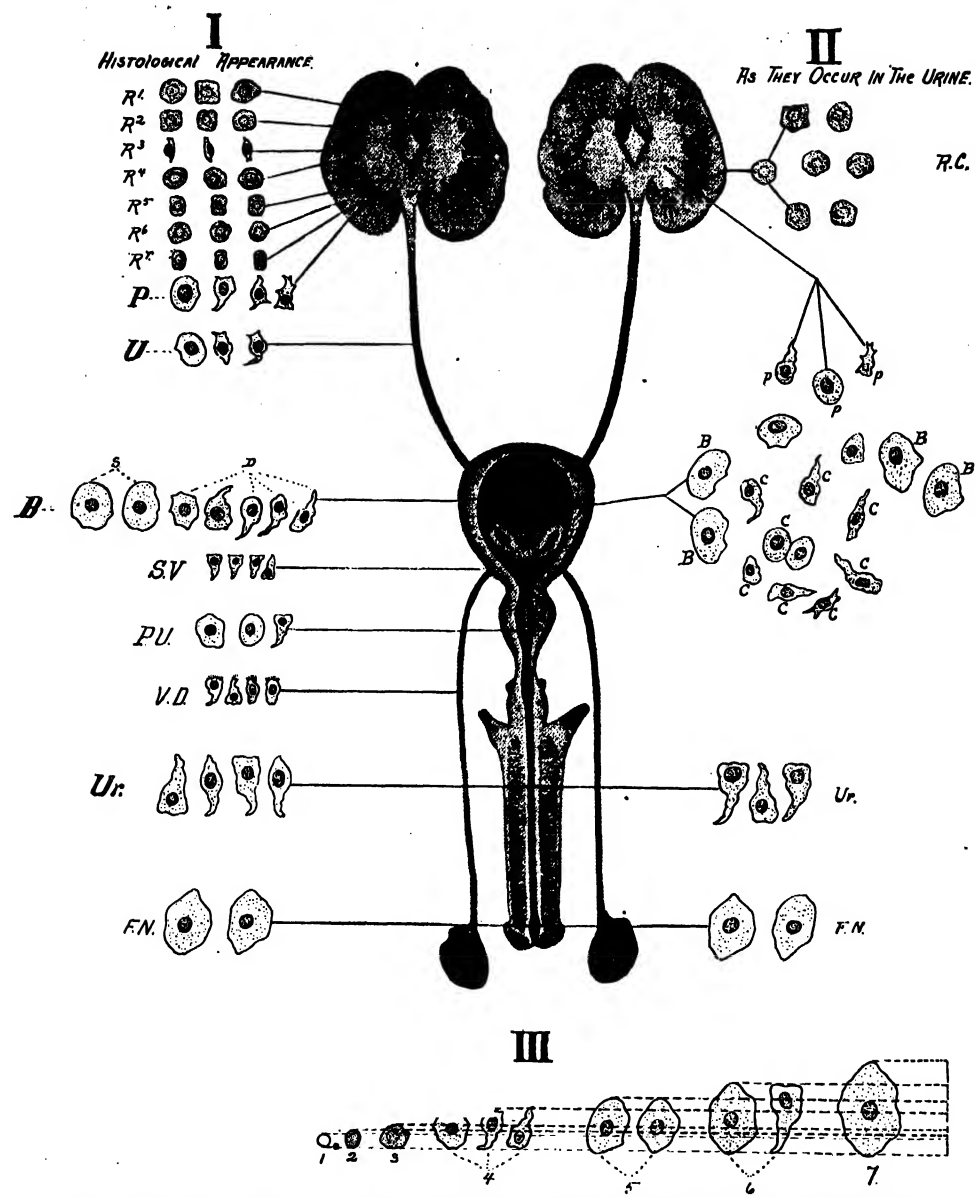


Fig. 103.—Epithelial Cells from Different Parts of the Genito-urinary Tract.

I.—The different varieties of these cells as seen histologically.

R^1, convoluted tubules.
R^2, spiral tubules.
R^3, descending and ascending limb of Henle.
R^4, loop of Henle.
R^5, distal convoluted.
R^6, arched collecting tubules.
R^7, straight collecting tubules.
P, pelvic cells.
U, ureteral cells.
Bs, superficial layer of bladder cells.
Bd, deep layer of bladder cells.
S.V, seminal vesicle.
P.U, prostatic urethra.
V.D, vas deferens.
U.R, penile urethra.
F.N, fossa navicularis.

II.—The groups of these cells recognized in the urine.

R.C, epithelial cells from renal tubules.
P, cells from renal pelvis.
B, superficial bladder cells.
Ur, penile urethra.
F.N, fossa navicularis.
C, cells belonging either to pelvis, deeper layers of bladder, prostate or ureter.

III.—Comparative size of epithelium found in the urine.

1, blood cell.
2, pus cell.
3, cells from the renal parenchyma.
4, renal pelvis, ureter, prostate and deeper layers of bladder.
5, superficial layers of bladder.
6, the penile urethra.
7, the vagina.

The largest epithelia in the urine are the flat superficial cells from the male anterior urethra, the vagina, vulva and female urethra. Next in size are the superficial squamous layers of the bladder. Next come the cells from the renal pelvis, the ureters, the prostate and the tubules of the kidney. The average size and the average shape should always be taken into consideration, not the many transitional sizes which are confusing. (See Fig. 103.)

(*a*) Renal Epithelium.—These cells are the most difficult, yet the most important, to identify in the urine. They do not occur in normal urine, save in such small numbers that they may be disregarded. Their presence in any numbers is indicative, at least, of renal irritation; when accompanied by or adhering to casts, they mean nephritis.

The chief diagnostic characteristic of renal cells is that they are at least one third larger than the pus corpuscles. This relation is constant. If the renal epithelia are small in a given case, the pus corpuscles will also be small. The illustration shows the comparative sizes of pus corpuscles and renal epithelia. The smallest group is that of red corpuscles, which are the smallest cellular elements in the urine. The next group is composed of pus cells. Then follow the smallest epithelia, the renal, which are one third larger than the pus cell. The next group shows cuboidal cells twice the size of the pus cell. These may be either from the ureter or from the prostate.

The epithelia from the straight collecting tubules are not frequently seen. They are about the same size as the epithelia from the convoluted tubule, but narrower and columnar in shape.

Renal epithelia, pus and pelvic epithelia, especially when accompanied by casts, are indicative of a pyelonephritis. It is important to look for epithelial casts and to compare the size and appearance of the epithelia on these casts with other renal epithelia found free in the urine. In this way we often confirm our opinion that a given set of round cells are from the kidney. It is always important, however, to compare the tubular epithelia with the pus cell.

(*b*) Epithelia from the Renal Pelvis.—These cells are of two types. The superficial layers shed a characteristic caudate, pear-shaped or lenticular cell. The deeper layers are represented by round or cuboidal cells, smaller than the bladder epithelia.

The caudate cells of the pelvis are distinguished from those of the ureter and from the columnar cells of the bladder by various features. The pelvic cells are twice the size of a pus cell; they have more distinct nuclei; their granules are well marked and they often have jointed or bifurcated tails. They are smaller than those from the bladder and slightly larger than those from the ureters. The presence of these caudates is characteristic, when present in large numbers and accompanied by pus, of pyelitis.

The round cells from the pelvis are not so characteristic, and fortunately are not so frequently seen, as they may be confused with renal cells. They

often occur in clumps of considerable size, are always accompanied by pus, and indicate chronic pyelitis.

(c) Epithelia from the Ureters.—These occur in the urine of uretero-pyelitis, stone in the ureter, etc. They are also found in normal specimens obtained by the ureteral catheter. There are two forms of ureteral cells. The majority of epithelia from the ureters are round or cuboidal, smaller than those of the pelvis but of the same size as those of the prostate. They rarely occur without pelvic epithelia, and can be differentiated only when the renal and pelvic cells are present. The ureteral epithelia are twice the size of a pus cell and are comparatively rarely seen. They resemble a small narrow caudate spindle, having a small bright nucleus. These cells are rarely found in sediments and are very similar to those of the deepest layers of the bladder, but are much smaller.

(d) Epithelia from the Bladder.—The *upper layers* of the bladder strata are flat. They occur in moderate numbers in normal urines, but in cystitis and other bladder diseases are greatly increased and modified. They occur either free or as fragments of cells irregular in size and shape. The largest of these flat cells are found near the neck of the bladder, and are apt to be confused with vaginal cells. The average superficial bladder cell, however, is smaller and has more rounded outlines than the vaginal cells. The latter also often contain bacteria.

The *middle layers* are composed of cuboidal epithelia. These are present in moderate or in large numbers in acute cystitis, in conjunction with cells from the upper layers. When chronic cystitis is present, the middle layers are represented by a majority of the bladder cells found in the urine, as by this time the superficial layers have been to a marked extent destroyed. In addition, in chronic cystitis, the cells present are found filled with fatty granules of various sizes, and many of them are in a state of partial disintegration.

The *deepest layers* of the bladder are composed of columnar cells which are rarely found in the urine, save in ulcerative processes, in tumors, and in cases of intense inflammation.

(e) Epithelia from the Ejaculatory Ducts and the Seminal Vesicles.—Epithelia from the ejaculatory ducts are elongated cylindrical and ciliated, though the cilia may be broken off. These cells are easily recognized by their shape.

Epithelia from the seminal vesicles are columnar, nonciliated, and sometimes contain a yellow pigment. They are rather larger, broader and less regular than the epithelia from the ejaculatory ducts.

Epithelia from the ejaculatory ducts and from the seminal vesicles occur in the urine in cases of seminal vesiculitis, and vesiculo-prostatitis. They are often associated with pus cells, urethral cells and prostatic cells.

(*f*) Prostatic Epithelia.—There are two types of epithelia from the prostate. The ducts of the gland are lined with columnar, the acini with cuboidal cells. The cuboidal epithelia are twice the size of pus cells, and are identical with the epithelia from the ureter. Prostatic epithelia, however, do not occur in association with renal and pelvic cells. They are apt to be associated with pus, with spermatozoa and amyloid bodies from the prostate.

(*g*) Epithelia from the Urethra.—The stratified lining of the urethra is represented in the urine by cells of a great variety of shapes. The superficial cells are present in the milder grades of inflammation and are squamous or cuboidal. They are always smaller than the bladder cells and larger than any other cells from the tract. The deeper layers of the urethra, with their smaller cylindrical cells, are less frequently represented, appearing in the deeper and more chronic processes. In such cases they show numerous fat granules and are often fragmented.

(*h*) Epithelia from the Vagina.—The largest cells in the urine come from the vagina. Usually the superficial squamous cells are represented; in fact, they are present in the urine of most women in health. In vaginitis, they are increased in number, accompanied by bacteria, mucus and pus. These cells may be found wrinkled or folded and show fine granules or fat globules.

The cuboidal epithelia from the middle strata of the vagina are found in severe, especially in chronic, vaginitis; and may contain fat granules. The columnar epithelia from the deepest layers are seen only in very extensive ulcerations. All vaginal cells are larger than those of the corresponding layers of the bladder.

(*i*) Epithelia from the Uterus.—These do not often occur in the urine. *They cannot be differentiated from urethral epithelia.* The mucosa of the uterus itself sheds cylindrical ciliated epithelia, the presence of which indicates endometritis.

4. **Urinary Casts.**—Three views are held as to the formation of casts: (1) That they are the result of the disintegration of the epithelium of the renal tubes, the resulting products being packed into molds by the pressure of the urine and at last forced out. (2) That they consist of a morbid secretion from the renal epithelium similarly caked into molds. (3) That they are formed from the coagulable elements of the blood (serum) albumin which gain access to the renal tubes through pathological lesions of the latter, and that any detached portions of the tubules become entangled in this coagulable product, assisting to form the mold which afterwards appears in the urine. This *latter* view is the one most generally accepted.

Casts may be conveniently divided for purposes of study, into ten kinds, viz.:

(*a*) Hyaline casts, whose origin and nature are still a matter of discussion, appearing as narrow hyaline, broad hyaline and composite casts.

(*b*) Granular casts, made up of a hyaline basis, containing granules of disintegrated leucocytes, and red and epithelial cells.

(*c*) Epithelial casts, made of unchanged anatomical elements, including red blood corpuscles, leucocytes, epithelial cells, or bacteria.

(*d*) Blood casts.
(*e*) Pus casts.
(*f*) Fatty casts.
(*g*) Waxy casts.
(*h*) Amyloid casts.
(*i*) Mixed casts.
(*j*) Cylindroids.

(*a*) Hyaline Casts (Fig. 104).—These are the pale structures of variable but usually considerable length, sometimes very difficult to detect in the sediment. Sometimes they are transparent and free from granules; more frequently they present fine granulations of a very light color. They may also have a few drops of fat or fragments of epithelium adhering to the surface. The origin of the hyaline cast has been variously explained as a result of secretion from the epithelia of the kidney, or as a coagulation of the albumin or its derivatives excreted with the urine. In support of the latter view it is stated that they are found only when the urine is albuminous, or has lately been so. The occurrence of albumin and casts may not be simultaneous.

It is a mistake to regard the presence of very small narrow hyaline casts as of no great importance, as is sometimes done, for they are often the chief urinary sign of the existence of a very grave disease of the kidneys, namely, chronic interstitial nephritis in which the albuminuria may be slight or absent.

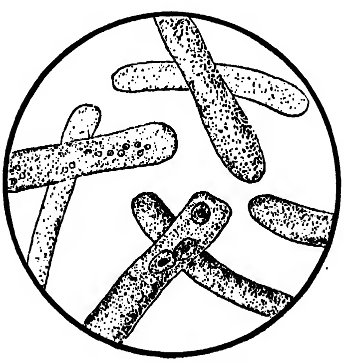


Fig. 104.—Hyaline Casts.

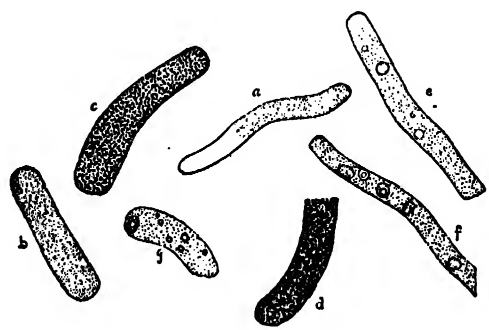


Fig. 105.—Granular Casts. (Ogden.)

a, granular cast.
b, finely granular cast.
c, coarsely granular cast.
d, brown granular cast.
e, granular cast with normal and abnormal blood adherent.
f, granular cast with renal cells adherent.
g, granular cast with fat and a fatty renal cell adherent.

(*b*) Granular Casts (Fig. 105).—This form of casts, resulting from the metamorphosis of anatomical elements, such as epithelium, pus, or blood, is found in the urine in great variety. The casts vary much in shape and appearance and are most often seen in fragments. They are irregular, in both fine and coarse outline, with ragged ends, the granules varying from those which

require the highest powers to discover to a relatively coarse size which gives its name to the cast. They are of various colors—yellow, gray, or brown—and may have scattered over their surfaces epithelium, leucocytes, fat globules, or fatty crystals. Granular casts have generally been regarded as evidence of pathological changes in the kidney of a chronic degenerative nature.

(*c*) Epithelial Casts (Fig. 106).—This form is due to pathological conditions which cause the exfoliation of the renal epithelium. At times this is thrown off intact for short distances, resulting in cylinders with lumens; or the cast may be solid, the body being hyaline and the epithelia adherent to it. The cells when seen under the microscope appear more or less swollen and granular, with ill-defined margins. Sometimes the epithelial cells appear as rows or patches scattered over the surface of the cast. In other cases the epithelia have undergone degeneration and present dots of fat, significant of chronic inflammation of the kidney and consequent fatty change. Finally, some casts consist of epithelial cells alone, glued together. Casts of epithelial variety are usually of medium size and length, refracting light to a marked degree and therefore easy to find with the microscope. They resist the action of chemical reagents more than most varieties. Epithelial casts always signify inflammation of the kidney and are therefore of great diagnostic worth.

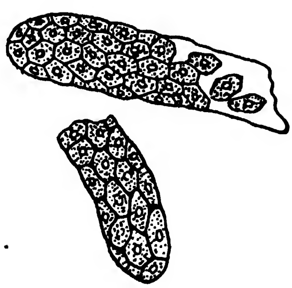


Fig. 106.—Epithelial Casts.

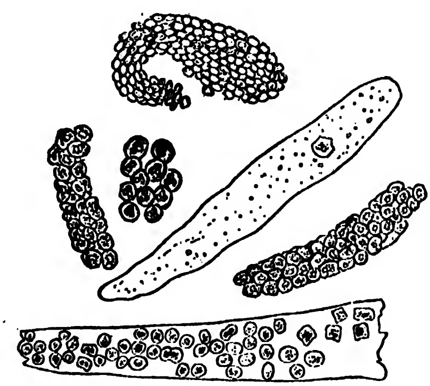


Fig. 107.—Blood Casts, Composed Wholly of Red or White Corpuscles or Hyaline Substance Covered with Blood Corpuscles.

(*d*) Blood Casts (Fig. 107).—Blood casts appear in the urine under conditions which cause hemorrhage in the renal tubules. The corpuscles may be well preserved and glued together to form perfect molds of the renal tubes, usually short and of uniform diameter with rounded ends.

These casts are found in nephritis, especially acute, in hemorrhages, acute renal congestion and hemorrhagic infarction of the kidney. They do not in themselves furnish positive proof of organic renal disease, but, on the other hand, blood casts are positive evidence of renal hemorrhage. These casts are among the rarer kinds and are usually hard to find, since a large sediment of blood corpuscles is apt to accompany them and obscure the microscopic field.

(*e*) Pus Casts (Fig. 108).—Casts composed altogether of pus are very rare. Compound casts, however, may present a few corpuscles here and there on their surface. They signify purulent inflammation in the kidney itself —i. e., pyonephritis or pyonephrosis. Bacteria are present in pus casts.

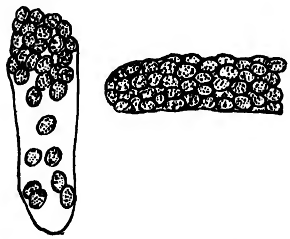


Fig. 108.—Pus Casts.

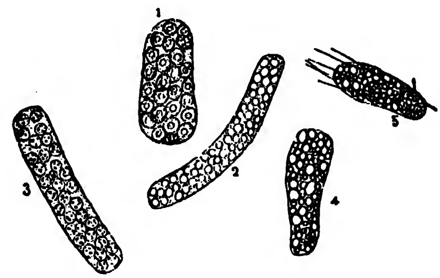


Fig. 109.—Fatty and Other Casts. (Ogden)
1, epithelial cast. *3*, pus cast.
2, blood cast. *4*, fatty cast.
5, fatty cast with compound granules and fatty renal cells adherent (crystals of the fatty acid protruding).

(*f*) Fatty Casts (Fig. 109).—Oil globules are often found adherent to many varieties of casts, whereas others are frequently seen which seem wholly made up of fatty material, including crystals of the fatty acids. These fatty acids indicate fatty changes in the kidneys and are found in their most typical form in the large white kidney. They suggest pathological states of the kidney whose chief feature is chronicity, since they are the result of complete destruction of the cell protoplasm, which is replaced by fatty elements.

(*g*) Waxy Casts (Fig. 110).—Waxy casts resemble somewhat hyaline casts. They are more refractive, and are yellow or grayish-yellow in color and differ furthermore in presenting a cloudy appearance. Unlike hyaline casts, they are not attacked by acetic acid. Though they resemble amy-

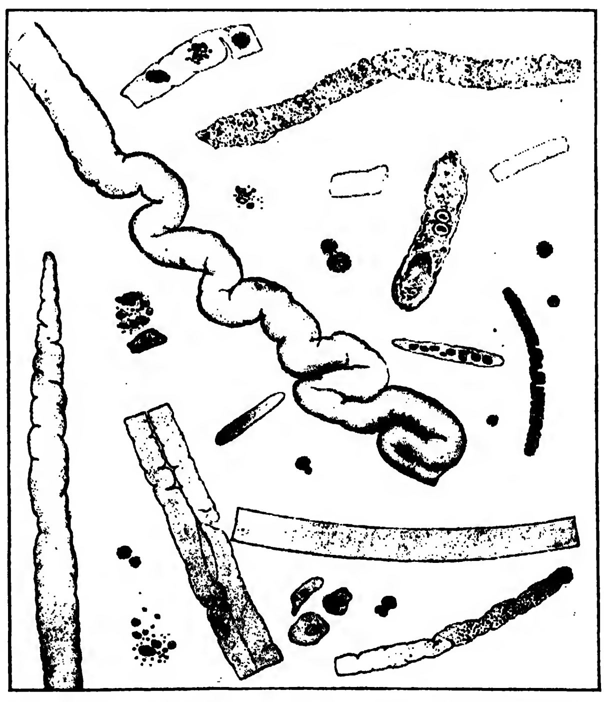


Fig. 110.—Types of Casts with a Waxy Matrix from a Case of Subacute Parenchymatous Nephritis. (Wood)

Some of the casts are quite transparent, others are granular at one end and clear at the other. Some are composed partly of granular matter and partly of waxy material. The casts vary greatly in size, but are all drawn to the same scale. One very small cast in the center is of the hyaline variety.

loid casts in appearance, yet their presence does not indicate amyloid disease of the kidney. It is possible that they were originally hyaline casts which have remained in the uriniferous tubules for a long time and have there undergone certain chemical changes analogous to "amyloid metamorphosis."

(*h*) Amyloid Casts.—Amyloid casts resemble in appearance waxy casts. They can be differentiated, however, by the addition of dilute iodopotassic iodid solution (Lugol's solution), when they assume a mahogany color which changes to a dirty violet upon the addition of dilute sulphuric acid. Waxy casts do not give this reaction. The presence of amyloid casts is indicative of amyloid degeneration of the kidney.

(*i*) Mixed Casts (Fig. 110).—The various kinds of casts are sometimes found in the same specimen, depending on the stage of pathological process in the kidney.

(*j*) Cylindroids (Fig. 111).—In addition to the varieties of casts mentioned, the urine may contain what are called cylindroids. These are long, wavy, ribbonlike structures, which often divide and subdivide at their ends. The ends may be folded or twisted. They are pale, colorless and of greater length than casts, and seldom have cells adherent to them. They appear flat and do not give the impression of being solid structures like the true renal casts. It seems probable, however, that these cylindroids come from the renal tubules. They occur in nephritis, cystitis and in renal congestion, and may be present in urine which contains no albumin. They are not characteristic of kidney disease, but rather of irritations of the lower urinary tract, which have extended to the kidney.

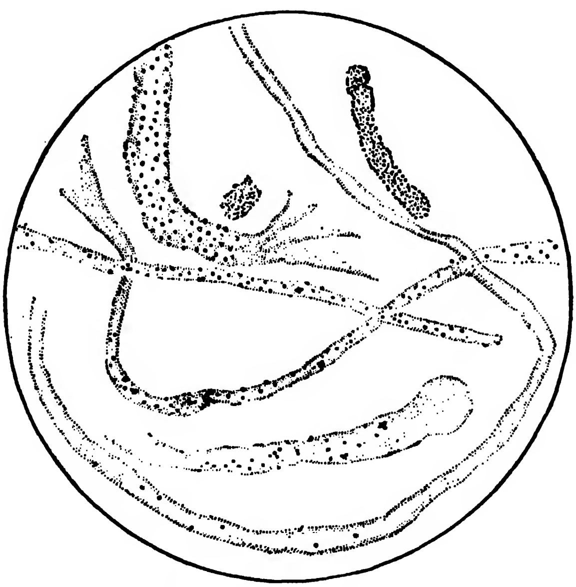


Fig. 111.—Cylindroids or False Casts. (After Peyer.)

Note.—To find casts with the least delay, the urine should be voided freshly, immediately centrifuged for three minutes, and four to six drops of the sediment taken up with the pipette and placed on a perfectly clean slide, a cover glass laid on, the excess urine removed by blotting paper, and the specimen examined with a quarter-inch objective in not too bright a light. Hyaline

casts may be overlooked, but when the focus has been carefully adjusted, if the field be darkened gradually till perhaps one third of the illumination is cut off, and the slide be moved slowly about, the contents of the field are viewed in different lights and the outlines or shadows of the hyaline casts may be detected. If doubt exists as to the nature of a cast, slight pressure on the cover glass will cause currents under it and cause the cast to turn.

5. **Shreds.**—Under the Microscopical Examination of Sediment, something should be said of shreds voided with the urine in an acute or chronic process of the genito-urinary tract. If they are derived from destructive processes in the bladder, prostate, or the kidney, they contain connective tissue. Shreds not due to destructive lesions are the result of subacute or chronic urethritis, prostatitis, pyelitis, or cystitis.

Several varieties of shreds may be distinguished: (1) Pus shreds, (2) mucous shreds, (3) muco-pus, and (4) epithelial shreds. The characteristics of these four varieties are sufficiently well marked to be readily recognized by the microscope.

Examination of Shreds.—They are carefully removed from the urine with a platinum loop and spread upon a slide with a few drops of water, teased apart with a needle if they are thick, and a cover glass placed over the specimen, after which their composition can be determined. For a bacteriological examination, the shreds can be stained like tissue sections. For this purpose the following method can be employed.

1. Fix with alcohol and ether for ten minutes.
2. Stain for one or two minutes with Unna's polychrome methylene blue.
3. Wash in distilled water. Dry.
4. Dehydrate for a few seconds in ninety-five-per-cent alcohol. Dry with filter paper.
5. Clear in xylol or in clove-thyme mixture.
6. Mount in balsam.

Massage Products in the Urine.—After massage of the prostate and vesicles, certain products may be voided with the urine and these should, therefore, be mentioned under Examination of Sediment.

In chronic inflammations and infections of the prostate and vesicles, the urine contains many pus cells and red blood cells, together with shreds. In seminal vesiculitis after massage, large masses of the secretion of the seminal vesicles, together with inflammatory detritus, are thrown off, looking like meal in the water, and sometimes like a thick white lump. These are often so large and thick as to block the urethra for an instant. In addition to these elements, the urine, after massage of the prostate and vesicles, very frequently contains other products, the significance and pathology of which are not quite so clear. I call them tapioca, sugar granules, skin flakes, and snowflakes.

Sago Bodies.—Sago bodies consist of round or ovoid masses, of a semi-opaque, yellowish-white, colloid material, varying in size from a barley corn to a lentil. Under the microscope they are found to consist of homogenous colloid matrix, in which are imbedded motionless spermatozoa.

Tissue Shreds.—Tissue shreds are never found in the urine under normal conditions. They are always evidence of tissue destruction or deep-seated inflammation, and are found in ulcerative conditions, in tuberculosis, trauma, tumors, and abscess of the prostate.

Sugar Granules.—These bodies resemble granules of melting sugar; they are much smaller than sago bodies, of the same transparency and light-yellow color. They are often present in large quantity, falling rapidly to the bottom and dissolving in a few minutes. Microscopically they are homogenous, structureless bodies, consisting of a highly refractive matrix, in which there are few or no spermatozoa and cellular elements.

Skins.—These are delicate, opaque, white, skin or membranelike fragments. They are composed of thickened inspissated vesicular secretion which has lain for a considerable time in the organ. They represent a deposit of secretion that has been formed in some of the recesses of the seminal vesicles and has been loosened and pushed through the ejaculatory ducts by massage. Skins are found especially abundant in men who have abstained from sexual intercourse for a long time, especially if a chronic catarrhal condition is present. Snowflakes represent a similar accumulation that has lasted but a short time and are much lighter and more flaky.

V. BACTERIOLOGY OF THE URINE

Although germs have been found in the urine of *healthy persons*, the majority of investigators state that the urine in health is sterile, provided it be obtained by sterile instruments and under proper precautions. The blood and the various tissues and organs of the body also are said to be free from bacteria in health. During and after infectious diseases, such as typhoid fever, grip, pneumonia, and septic infection, germs are often found in the urine.

Inasmuch as the urethra is always inhabited by saprophytic bacteria, the urine flowing from the meatus can hardly be expected to be absolutely sterile, all the more so because it is often mixed with bacteria from the surface of the glans and prepuce in men and from the vulva in women. Therefore, an ordinary specimen of urine freshly passed even in health will certainly contain some bacteria.

Experiments have proved that the urine possesses bactericidal properties in health and shown that the absence of bacteria from normal persons may mean that the germs have been destroyed by virtue of this property. It has also been shown that fresh urine has the property of destroying the anthrax, cholera

PLATE II

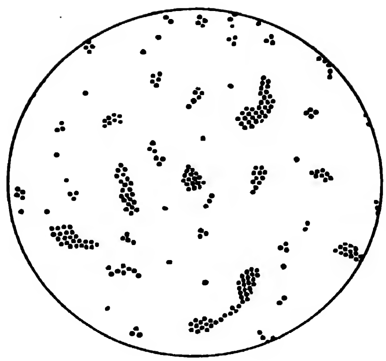


Fig. 1.—Staphylococcus pyogenes aureus.

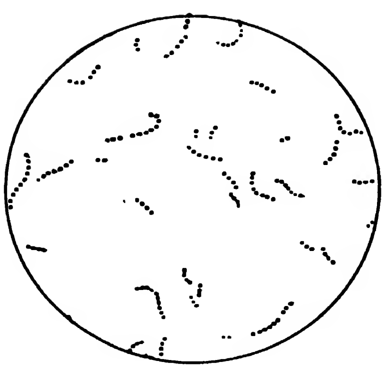


Fig. 2.—Streptococcus pyogenes.

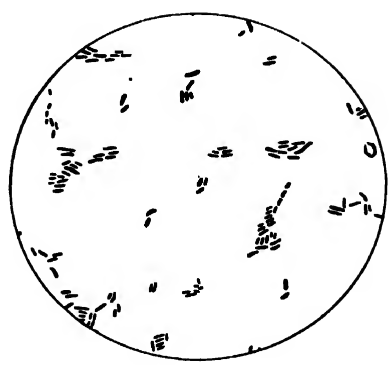


Fig. 3.—Bacillus coli.

BACTERIA FOUND IN THE URINE.

and less constantly the typhoid bacilli, by virtue of the presence of the acid-potassium phosphate. If the urine is neutralized by addition of alkalies, its bactericidal property tends to disappear. Possibly the chlorids or some other constituents may also act as antagonists of the bacteria.

In disease, the bacteria which may occur in the urine are many. A few of them, however, are of importance, as they play a prominent rôle in the causation of urinary affections. These important special germs are the gonococcus, the tubercle bacillus, the colon bacillus, the Streptococcus pyogenes, and the Staphylococcus pyogenes aureus and albus, the Bacillus proteus of Hauser, the typhoid bacillus, which occurs in the urine in typhoid fever, and rarely the Bacillus pyocyaneus. Still more rarely the pneumobacillus of Fraenkel is found. In certain infectious diseases, such as anthrax, plague, etc., the corresponding germs have been found in the urine. With the exception of the last-mentioned germs, which are rarely found in the urine, all the above-mentioned germs have been known to produce cystitis. The following is a list of germs concerned in the causation of suppurative inflammations of the kidney, ureter, and bladder in the order of frequency:

1. The colon bacillus,
2. The Bacillus proteus vulgaris,
3. The Staphylococcus pyogenes,
4. The Streptococcus pyogenes,

   These may be saprophytes in the urethra, especially in the female.

5. The tubercle bacillus,
6. The gonococcus.
7. The typhoid bacillus.
8. The Bacillus pyocyaneus (rare).

The gonococcus is found in the urine in gonorrheal infections of the urinary tract and the tubercle bacillus in tuberculous infections. The germs of suppuration, such as the streptococcus and staphylococcus, and the colon and proteus bacillus are found in suppurative conditions of the kidneys, pelvis, ureters, etc.

Bacteria in the Urine

Mode of Entrance.—Germs may be introduced from the urethra or from the outside into the bladder either by unclean instruments or simply by pushing germs present in the urethra into the bladder with sterile instruments. A urethral infection also may be transmitted by continuity to the bladder, where the germs will then appear in the urine. If the bladder is sterile and the urine therein free from germs and if the urethra is infected, the urine, of course, may wash numerous germs from the urethra into the vessel in which the sample is collected. These modes of infection of the urine are practically self-

evident. Infection of the urine in the bladder by germs transmitted from the normal urethra does not occur in man, owing to the fact that the vesical sphincter shuts off the bladder from the urethra. On the other hand, in women, bladder infection may occur through the healthy urethra.

In addition to an infection from the urethra upward, the urine may become contaminated also by the entrance of bacteria into the kidney through the circulation (especially of the tubercle bacillus), and by the passage of bacteria into the bladder through the intestinal wall.

The question of a descending infection has been demonstrated both experimentally and clinically. It is difficult to understand at first how bacteria can infect the kidney from the bladder when the stream of urine apparently tends to prevent this by opposing the ascent of the germs. Animal experiments, however, have shown that under certain conditions, the contents of the bladder regurgitate into the pelvis of the kidney. When the germs reach the pelvis, they may enter through the lymphatics of the kidney, less frequently through the urinary tubules, and more rarely through the capillaries of the kidney. The entrance of germs from the blood through the kidneys into the urine has been repeatedly demonstrated. Germs may enter the bladder directly from the intestine in cases in which the bladder is damaged, or from the intestine into the blood and thence into the kidney.

The Gonococcus in the Urine.—To avoid repetition, we have grouped all data on the gonococcus in the chapter on the Examination of Urethral Discharges.

The gonococcus is usually found in the urine in urethritis, sometimes in prostatitis and vesiculitis after massage, and occasionally in cystitis, pyelitis and pyelo-nephritis in ascending infections of gonorrheal origin. The germ is much more difficult to detect in the urine than in smears of discharge. In the urine, it is always accompanied by pus and is to be looked for within the cytoplasm of the pus cells, or upon the epithelia of the sediment. The methods of obtaining and precipitating the sediment for such examination has been given in the preceding pages.

The Tubercle Bacillus.—The tubercle bacillus occurs in the form of a small rod, one quarter to one half as long as the diameter of a red blood corpuscle. The rods are delicate, straight, slightly bent or curved, and somewhat beaded. They occur either singly or in groups, especially in the form of tufts which are commonly found in the urine. At times they are found also within the body of the pus cell. In some specimens, the ends of the rods are somewhat clubbed or branched, or present swellings at different points. In stained preparations, the bacilli show alternation of stained and colorless portions.

Method of Staining.—The detection of the tubercle bacillus depends upon its characteristic behavior toward anilin dyes and decolorizing agents. The penetrating power of the dye used must be increased by the addition of

PLATE III

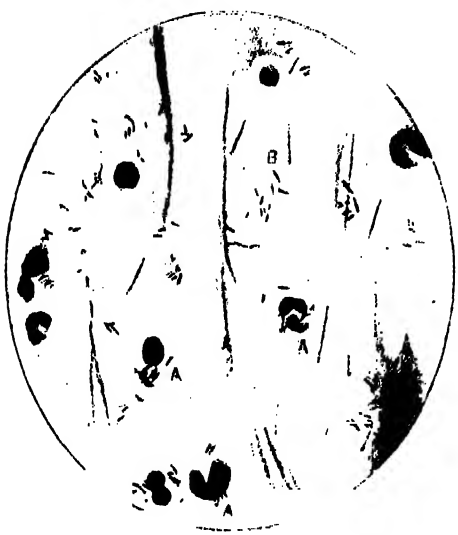


FIG. 1.

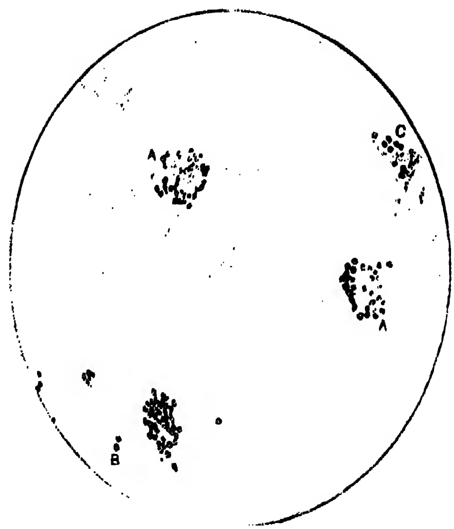


FIG. 2.

BACTERIA, SHOWING THE OPSONIC ACTION INCREASED BY THE PROPER ADMINISTRATION OF BACTERIAL VACCINES.

FIG. 1.—TUBERCLE BACILLI IN SPUTUM. The tubercle bacilli are stained red with carbolfuchsin. At *A* the bacilli are *inside* the leukocytes, showing phagocytosis, or that the bacteria have been prepared for ingestion by the opsonins. *B* shows the bacilli *outside* the leukocytes not prepared for ingestion by the opsonins.

FIG. 2.—GONOCOCCI IN URETHRAL PUS. The gonococci are stained with methylene blue. At *A* the cocci are *inside* the leukocytes, showing phagocytosis, or that the bacteria have been prepared for ingestion by the opsonins. *B* shows cocci *outside* the leukocytes not prepared for ingestion by the opsonins. *C* shows the cocci having probably been ingested by the white blood-corpuscles, but the toxins of the gonococci have destroyed the leukocytes.

either carbolic acid or anilin oil and by the application of heat. Once stained in this way, the bacilli resist acids, and upon this depends the differentiation from other bacteria in the same specimen.

Ziehl-Neelsen Method.—This is the method in common use for staining tubercle bacilli in the urine.

The sediment is obtained in as concentrated a form as possible, and spread in a thin layer upon a slide or cover glass and allowed to dry in the air. The preparation is then fixed in the usual way in the flame of a Bunsen burner. The specimen is then covered with some filtered Ziehl-Neelsen carbol-fuchsin solution (five-per-cent aqueous solution carbolic acid, ninety parts; saturated alcoholic solution of fuchsin, ten parts) and held over the flame of a Bunsen burner, allowing the solution to steam for one or two minutes without bringing it to the boiling point. The specimen is then washed in a stream of running water and immersed in five-per-cent sulphuric or thirty-per-cent nitric acid. The film turns yellow or brown, but, on washing again in water, the red color reappears. The operation is then repeated until only a very faint tinge is left and no more of the stain is given off. The specimen is now washed for from ten to fifteen minutes in strong (ninety-five per cent) alcohol, followed by rinsing in water. In staining a urine specimen, the use of alcohol is an important step as a means for excluding the smegma bacillus, which is decolorized by alcohol. The specimen is now covered with a weak, watery solution of methylene blue, which is allowed to remain for from one to two minutes. After washing and drying, the specimen is ready for examination with an immersion lens.

Differentiation.—The tubercle bacillus may be confounded morphologically with two different germs: the smegma bacillus and the leprosy bacillus.

The *smegma bacillus* is most often confounded with the tubercle bacillus. It occurs in the decomposing secretion around the genitals. In obtaining specimens of urine for examination for tubercle bacilli, care must be taken, first, to wash the external genitals with soap and hot water, so as to remove any smegma germs, and then to draw off the urine with a sterilized catheter. If, in addition to these precautions, the specimens are washed in alcohol after decolorizing, as previously mentioned, there is very little danger of error in the microscopical diagnosis.

The *lepra bacillus* resembles the tubercle bacillus both in shape and staining properties, but is somewhat shorter, thicker, and stains unevenly. It occurs, however, so rarely, that its differentiation from the tubercle bacillus need not be discussed here.

Animal Inoculation.—In case of doubt as to the nature of the bacillus and in instances in which repeated examinations of urinary sediments do not show any tubercle bacilli, although clinically tuberculosis is suspected, recourse may be had to inoculation of animals and to cultures on artificial media. The material should be introduced subcutaneously or into the peritoneum, the former

method taking from four to ten weeks, the latter from ten to twenty days for tubercular lesions to develop when tubercle bacilli are present. If smegma bacilli only are present, no lesions develop. At the end of the time stated, an autopsy is performed upon the animal, and the site of puncture, the peritoneum, the lungs, and other organs are examined for tubercles.

The Colon Bacillus.—The colon bacillus occurs normally in the intestine of man, bovines, dogs, and other domestic animals. Its close resemblance to the typhoid bacillus makes it an object of interest. Certain features, however, distinguish it from the typhoid bacillus, and it is regarded as a distinct species of germ. The colon bacillus may under favorable conditions produce serious disease. It is the cause of local suppuration in a great variety of organs, and also produces at times general septic infection. The colon bacillus plays an important rôle in urinary affections, as it is one of the chief germs concerned in the causation of cystitis, and is found also in the urine and the purulent sediment in cases of infection of the kidney, the pelvis, and ureter.

MORPHOLOGY.—The colon bacillus occurs in the form of rods, with rounded ends, which may vary in two directions: they may be either so short as to appear almost like cocci or so long as to resemble threads. No spores have been demonstrated, but flagella may be shown by Loeffler's method. It is motile in most cases, but often its movements are very slow.

STAINING PROPERTIES.—It stains with ordinary anilin dyes and is decolorized by Gram's method.

Streptococcus Pyogenes.—The Streptococcus pyogenes is the cause of local inflammatory and suppurative processes and of general infections such as septicemia. In the urinary tract it is found in inflammatory conditions of the urethra, bladder, kidney, pelvis, and ureter, either alone or more generally in company with other germs of suppuration, as the tubercle bacillus, with which it is very frequently associated.

The Streptococcus pyogenes occurs in the form of chains of minute round or oval cocci resembling strands of beads. Sometimes two or more cells in the chains coalesce to form a somewhat longer segment. The chains may be short, consisting of a few cells, or very long. Sometimes the cocci composing a chain divide simultaneously, so that a chain of diplococci may be seen. The streptococcus stains easily with anilin dyes and usually stains with Gram's method.

Staphylococcus Pyogenes Aureus.—The Staphylococcus aureus is the most common of the germs of suppuration. It occurs in abundance everywhere, and is the usual cause of wound infection. It is present in the normal as well as the diseased urethra, is frequently found in the bladder in cystitis, and plays a prominent part in infections of the kidney, either alone or accompanying other germs, as the colon bacillus, the streptococcus, etc. In tuberculosis of the urinary tract, it is often present as a complicatory organism, along with other germs of suppuration.

It occurs in the form of round or oval cocci arranged typically in clusters, but often in pairs. In preparations from pus, they are found outside the pus cells, rarely within these bodies. It stains readily with the basic anilin dyes and is not decolorized by Gram's method.

Staphylococcus Pyogenes Albus.—Microscopically, this variety cannot be differentiated from the Staphylococcus pyogenes aureus. The difference between the two lies in the appearance of the cultures. The occurrence and significance of the two varieties are very similar.

Bacillus Proteus Vulgaris.—The Bacillus proteus frequently occurs in cystitis. It occurs as short and long bacilli, and also in the form of threads. It is markedly motile and shows numerous flagella. It stains well with basic anilin dyes and is not decolorized by Gram's method. It forms grayish-white, minute colonies upon agar, which later coalesce into a dirty-gray translucent film. On gelatin it grows in the form of grayish-white colonies and liquefies the medium rapidly.

The proteus is frequently found in suppurative conditions in the urinary tract, especially in cystitis. Experimental cystitis has been produced by injecting cultures into the bladder in animals.

Bacillus Pyocyaneus.—The Bacillus pyocyaneus, or bacillus of green pus, is mentioned here as a germ occasionally found in cystitis. It is found in fetid pus from wounds. It is a delicate rod with rounded or pointed ends, actively motile and does not form spores. It occurs in irregular masses or singly; grows on all the ordinary media, giving a characteristic green color to the same, which becomes blackish in old cultures. The bacillus stains with the ordinary anilin dyes.

Other Microorganisms of Minor Importance.—The rays or granules of *Actinomyces* may be found in the urine when this infection affects the genito-urinary tract or when this fungus is present in the system and finds its way into the urine.

The *Micrococcus ureæ* is the germ which occurs in long chains consisting of large cocci. It occurs in urines undergoing ammoniacal fermentation and decomposes urea into ammonia.

Yeast cells and *molds* of various kinds are very often found in the urine, entering either from the air or as a result of contamination from the vessels in which the urine is collected.

Methods of Examining the Urine for Bacteria

Specimens of urine which are to be examined bacteriologically should be obtained from the bladder by means of a sterile catheter (introduced after copious washing of the urethra with boric-acid solution), collected in a sterilized bottle, and handled thereafter only with sterile apparatus. Before introducing

the catheter, the external genitals in either sex should be thoroughly cleansed with soap and hot water and the smegma removed from the neighborhood of the orifice of the urethra. The urine should be examined, as a rule, as soon as obtained, especially when looking for tubercle bacilli, so as to prevent decomposition and multiplication of extraneous germs.

Centrifugation is a rapid and most satisfactory method of obtaining bacterial sediments. The centrifuge sediment is drawn up by a slender pipette, and spread on slides and allowed to dry. The spread preparations are then fixed by immersing in alcohol and ether, equal parts, or by passing slowly through the Bunsen flame. Care must be taken always to spread the film very thinly. The successful fixation of the sediment depends upon the presence of a certain amount of pus containing coagulable proteid substances. When these are absent in the urinary sediment, as sometimes is the case, fixation on the slide is not easily accomplished without the addition of egg-albumen. The sediment is taken up with a platinum loop and spread upon a slide, upon which a drop of a mixture of egg-albumen and glycerin has previously been placed, and then fixed as already described.

Shreds from the urethra, clumps of fibrin, masses of epithelium and other tissue elements which may be found in the urine, may be examined for bacteria after being fished out with a platinum loop and spread on the slide and stained. They are fixed and stained in the same manner as the other smears from the urinary sediment, but especial care should be taken to spread them very thinly by means of a platinum needle. It is difficult to detect germs in these shreds of tissue under the best conditions.

When the bacteria looked for are absent from the sediment on microscopical examination of stained preparations, cultures and inoculations into animals may be resorted to—methods to be employed when the importance of the diagnosis requires them. The details of cultivation and animal inoculation are given under the headings of the respective germs.

CHAPTER IV

DISCHARGES

Under this heading we shall consider the character of all discharges from the genito-urinary tracts of men and women, whether they be normal or abnormal. In the list of discharges are included urethral, prostatic and seminal elements, which are best considered under the headings of:

Urethrorrhea,
Prostatorrhea,
Spermatorrhea,
Nonspecific Urethritis,
Tubercular Urethritis,
Syphilitic Urethritis,
Chancroidal Urethritis,
Acute Gonorrheal Urethritis, anterior and posterior,
Chronic Gonorrheal Urethritis,
Chronic Prostatitis,
Chronic Vesiculitis.

Discharge for examination is taken in the following manner:

Taking of the Specimen.—In men, take a slide between the thumb and forefinger of the right hand (Fig. 112), and the glans in the same way with the left

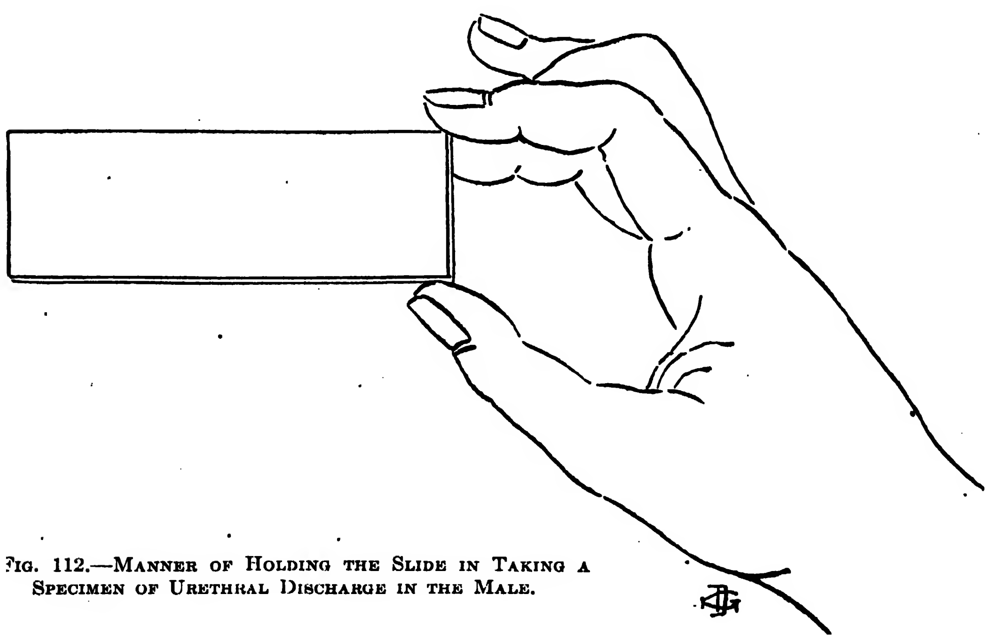


Fig. 112.—Manner of Holding the Slide in Taking a Specimen of Urethral Discharge in the Male.

hand, and apply the surface of the slide to the meatus (Fig. 113). The discharge on the glass should then be smoothed out on the slide. If none is apparent, draw the finger along the urethra and express its contents from the meatus. If nothing appears, insert a platinum loop (Fig. 114) into the fossa navicularis and even farther down the canal to see if some can be obtained. If so, the secretion adhering to the platinum loop can be smoothed out on the surface of the slide for examination. When the discharge is abundant, a sufficient amount can be taken on a platinum loop for examination and it is not necessary to apply the slide to the meatus.

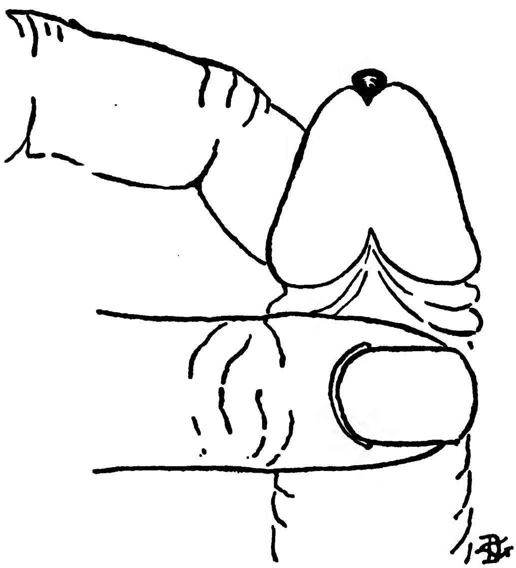


Fig. 113.—The Urethra Squeezed Between the Thumb and Forefinger and Pus Appearing at the Meatus.

In women, the patient should be placed on the table with the feet in the stirrups. If there is a discharge about the vulva, a slide can be pressed against it and smear No. 1 can be taken.

The vulva should then be sponged until cleansed. This exposes the openings of the vulvo-vaginal glands on the inside of the labia majora, so that the contents can be expressed by the finger placed upon the gland and drawn along

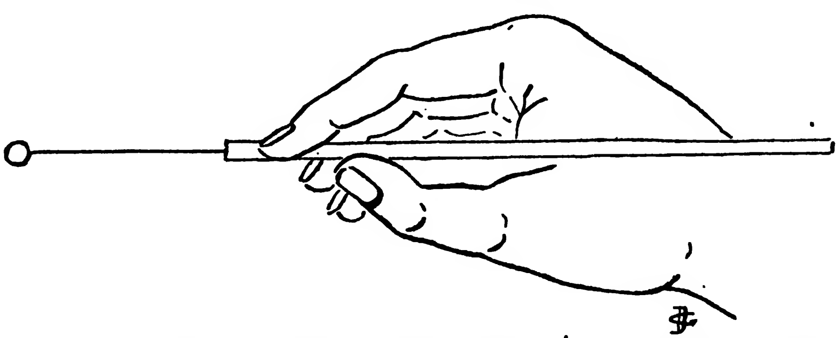


Fig. 114.—Platinum Wire to be Passed Down the Urethra, to Take Some Discharge from the Walls.

its duct. If discharge appears, it should be taken on a slide smear No. 2. The labia should then be separated by the thumb and forefinger of one hand, when discharge may be seen at the meatus. If none is seen, the forefinger of the other hand should be inserted into the vagina as far as the bladder and then drawn along the urethra (Fig. 115), by which means a drop of moisture may

appear at the meatus. The smear is then obtained by placing the slide against the mouth of the urethra, or else by taking it with a platinum wire (Smear No. 3). A speculum should then be introduced into the vagina and its wall and the cervix uteri examined. If discharge is seen at the orifice of the cervical canal, it can be taken by means of a forceps, a swab or a platinum loop and then placed upon a slide (Smear No. 4). Figs. 116 and 117 show slides with smears.

FIG. 115.—FORCING THE DISCHARGE OUT OF THE FEMALE URETHRA BY PRESSURE AGAINST THE CANAL WITH THE TIP OF THE FINGER IN THE VAGINA.

The specimen can then be taken on a slide or by platinum loop.

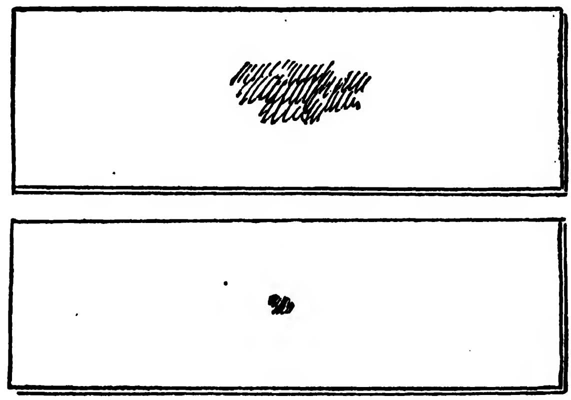


FIG. 116.—SMEARS ON SLIDES.

The slides are then placed one on the other with the smear between them.

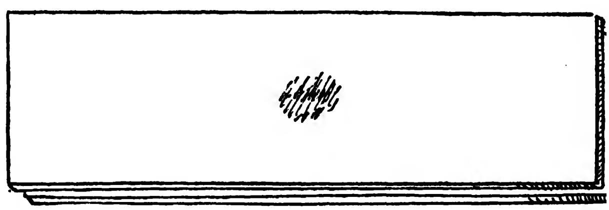


FIG. 117.—THE SLIDES TOGETHER.

They are wrapped up, the name inscribed, and sent to the laboratory.

Urethrorrhea *ex libidine* consists of a scant, mucoid discharge which occurs as an oozing in conditions of sexual excitement. It is in all probability due to an exaggerated activity of the muciparous glands of the urethra and is interesting because its appearance, when noted by the patient, is apt to frighten one into the belief that he has some urethral disease, or that he is losing semen.

Under the microscope it shows the presence of urethral epithelia, mucus, a few leucocytes and a variety of bacteria normally present in the urethra. It represents merely an excess of the normal secretion, from which it differs in no way when examined microscopically.

The discharge is to be distinguished from prostatorrhea and from spermatorrhea by the absence of the Böttcher's crystals, in the first instance, and of spermatozoa in the second. It is differentiated from the discharge of chronic urethritis by containing fewer epithelia, and the absence of pus cells and of pathogenic germs.

Prostatorrhea.—Prostatorrhea consists in a leakage of prostatic fluid from the ducts of the prostate. It is characterized by a discharge of a white, viscid substance from the meatus during defecation, after urination, at times of sexual excitement and sometimes on arising after a morning erection. The fluid is free from mucin, but rich in proteid substances.

Microscopic examination shows cylindrical epithelia, leucocytes, lecithin globules, amyloid bodies and "Böttcher's" sperm crystals. A few spermatozoa also may be found. Böttcher's crystals are rendered more distinct if a drop of one-per-cent solution of ammonium phosphate is added to the discharge (Fig. 118). They are rhombic prisms ending in fine points or rhombic margins. If one of these prisms lies upon the other a cross is formed and if several are placed across each other a rosette is produced.

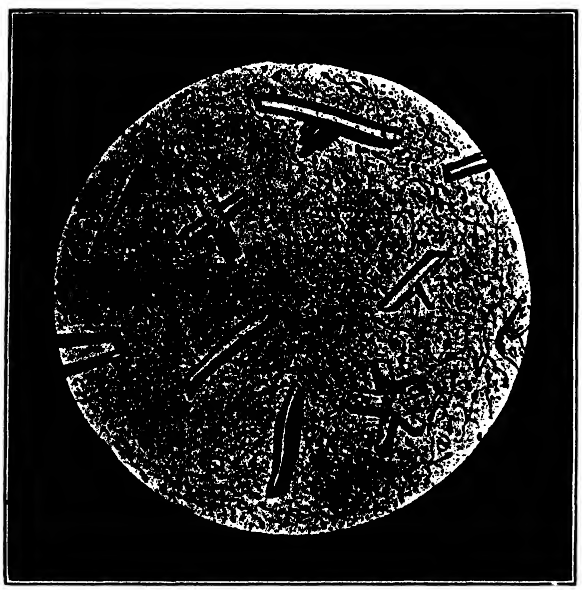


Fig. 118.—Spermatic or Böttcher's Crystals. (From Casper.)

Spermatorrhea.—Spermatorrhea is an atonic condition, due to passive congestion and leakage from the urethra and all contributing genital channels. It is characterized by oozing out of the semen, with or without erection or pleasurable sensation, due to erotic thoughts, or light mechanical stimuli. It may, however, occur after urination and defecation, as in prostatorrhea. It is thick and viscid and under the microscope shows large numbers of spermatozoa, by which it is differentiated from prostatorrhea. Amyloid bodies may or may not be present. Besides spermatozoa, the discharge contains testicular cells, cylindrical epithelial cells from the seminal vesicles and the prostate, flattened epithelial cells from the urethra, large round cells from Cowper's glands and pigment granules.

Nonspecific Urethritis.—Nonspecific urethritis is an inflammation of the urethra caused by infection with other germs than the gonococcus, or by ren-

dering active the saprophytic germs that may be present in a normal urethra in a quiescent state. Any irritant may render the quiescent germs active. If an irritant is injected into the urethra, such as strong solution of silver nitrate, there develops within a few hours a fairly abundant purulent discharge, a nonspecific urethritis which to the naked eye appears very much like the beginning discharge of true gonorrhea. It varies in amount and from white to yellow in color. On microscopical examination, this discharge presents a large number of fairly normal epithelia from the superficial layers of the urethra, including the cuboidal and the columnar varieties, as well as the flat cells from the fossa navicularis. The epithelia are mixed with a more or less abundant amount of pus, and among and within the pus cells may be noted numerous microörganisms belonging to the normal urethral flora; also Staphylococcus albus, colon bacillus or streptococcus.

Tubercular Urethritis.—Tubercular urethritis is nearly always situated in the prostatic urethra and secondary to tuberculosis of the prostate. The discharge is scanty, mucoid, muco-purulent or purulent in character, the amount of pus depending upon the presence or absence of mixed infection. The microscope shows the presence of such bacteria as are found in nonspecific urethritis, mucus, urethral epithelia, pus, tubercle bacilli, other microörganisms of secondary infection and connective-tissue shreds. When the prostatic urethra is involved in cases of tuberculosis of the prostate, prostatic tissue may also be found. The specimen is placed on a slide in the way already outlined and it is stained and examined in the manner already described in the chapter on The Urine.

Syphilitic Urethritis.—Syphilis may involve the urethra in two ways: First, as the initial lesion or hard chancre just within the meatus, and, second, as an ulcerating gumma of the glans in the later stages which extends into the urethra.

When the initial lesion is in the form of an erosion, the discharge is usually scanty in amount and ranges from a thin mucoid to a sero-sanguinolent or puro-sanguinolent consistency. It is sometimes quite profuse when due to an ulcerating chancre. Microscopical examination shows few red blood cells, pus cells, mucus, urethral epithelium and many bacteria. The active organism of syphilis is the Spirocheta pallida.

The Spirocheta pallida (Schaudinn) (Fig. 119), or more correctly, Treponema pallidum, is a slender spiral-shaped, very motile organism with pointed ends, 4 to 14 micromillimeters in length, ¼ micromillimeter in width. The number of its corkscrew-like spirals is extremely variable, and typical forms have been noted with as few as two to four, or as many as twenty and more, twists. In the other treponema of this group, for example, the Spirocheta refringens, the individual twists are fewer, larger and more wavelike. The Spirocheta pallida is present in practically all acquired syphilitic lesions, including

genital and extra-genital chancres, moist papules, indurated lymph glands, and mucous patches, on the surface as well as in the interior of the tissues and in the blood. All the organs of the body, notably the suprarenal glands, the spleen and the liver, have been found to contain it in congenital syphilis. This microörganism has never been encountered in any disease except syphilis. Negative findings in an initial lesion do not prove that the lesion is not a chancre, as in typical initial lesions we have failed to find it in repeated examinations.

FIG. 119.—SPIROCHETA PALLIDA.

The Spirocheta pallida may be demonstrated in the secretions from initial lesions of syphilis in two ways: (1) Direct examination of the living organism by a reflecting condenser under dark ground illumination; (2) by the staining methods of Goldhorn and Giemsa.

The specimen is obtained as follows: The part is washed clean from discharge with boric-acid solution. The syphilitic lesion is then lightly curetted with a small sterilized curette until blood begins to ooze; the blood is carefully sponged off with sterile gauze and usually stops in a few minutes, after which serum will be seen to ooze from the lesion. A sterile glass slide is lightly touched to this serum and the specimen is fixed and dried like ordinary blood smears.

FIG. 119a.—SPIROCHETA AS SEEN BY GOLDHORN STAIN.

METHODS OF STAINING THE SPIROCHETA PALLIDA

I. *Goldhorn's Method:*

Goldhorn's Spirocheta Stain is used.

1. Cover unfixed preparation with dye. (The Goldhorn Spirocheta Stain.)
2. Pour off excess of dye in three or four seconds and immediately plunge the whole slide gently face downward into water to prevent precipitation of the stain.
3. Hold in water for three to four seconds and wash.
4. Dry. (Do not let the slide lie flat while drying, but stand it up or shake in the air.)
5. The specimen is then mounted by dropping on a drop of Canada balsam and placing a cover glass over it. It is examined microscopically with a $\frac{1}{12}$ oil-immersion lens.

II. *Giemsa's Method:*

1. Clean a test-tube by boiling in soda solution, after which wash thoroughly and dry.
2. Put thirteen drops of Giemsa's Solution II in the test-tube and add 10 c.c. of a 0.5-per-cent solution of chemically pure glycerin in distilled water.
3. Warm this solution in flame.
4. Cover fixed preparation with stain, and after five minutes pour off and cover again with fresh solution; after five minutes wash, dry and mount, and examine with $\frac{1}{12}$ oil-immersion lens.

The reflecting condenser under dark-ground illumination offers a rapid and accurate method for the observation of the living spirocheta. This apparatus (Fig. 120) can be attached to the stage of any microscope and held in position by the ordinary clips.

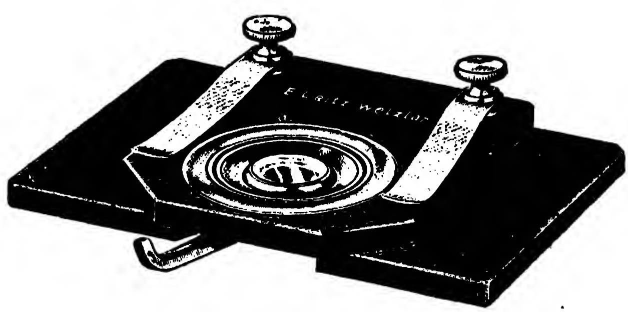


FIG. 120.—REFLECTING CONDENSER.

The condenser is provided with two reflecting surfaces, as shown in Fig. 121 on next page. The parallel rays of light coming from below (that is, from the plane mirror of the microscope), are almost completely united in one point "P." An intense illumination of the spirocheta and other organ-

isms is thus obtained. The light diffused by the bacteria, as represented by dotted lines, enters the objective and thus produces an image of the bacteria. The best source of light for dark-ground illumination is furnished by a small arc light (Fig. 122). But where this is not available, a Nernst lamp or an incandescent gas lamp may be used, in which case, it is necessary to employ a bull's-eye lens on a stand, so placed that it is between the source of light and the reflecting mirror of the microscope; the distance between the light and the lens should be 17 cm. and between the lens and mirror reflector of the microscope 40 cm.

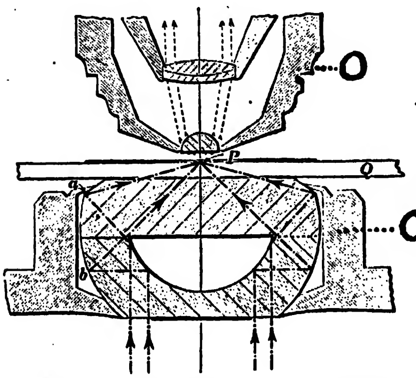


FIG. 121.—REFLECTING CONDENSER.
Q, glass slide with cover glass.
a, *b*, reflected rays meeting at *P*.
C, condenser apparatus.
O, objective.
P, point of concentration of the rays.

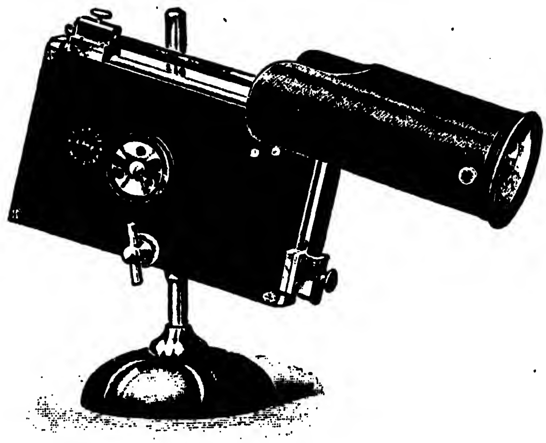


FIG. 122.—ELECTRICAL ARC LAMP WITH HAND FEED FOR A CURRENT OF 4 AMPERES AND AN ILLUMINATING LENS MOUNTED ON A STAND.

The specimen to be examined is taken on a slide, but the serum is not allowed to dry; a drop of distilled water is added to it and a cover glass placed over it, and the specimen is examined in the wet state. The slide is now placed on the condenser and, the source of light having been adjusted, it is then examined either with a dry or an oil-immersion lens. The object slide and cover glass must be thoroughly clean, as dust particles interfere with the observation; the preparation itself should be very thin and the specimens must not contain any air bubbles.

Chancroidal Urethritis.—This is the result of infection of the meatus by chancroidal virus and an extension of a few millimeters down the canal. The discharge is moderately profuse in amount and muco-purulent or muco-sanguinolent or puro-sanguinolent in character. Microscopically, mucus, epithelium, pus cells, pus-producing organisms, Bacillus of Ducrey and sometimes blood are found. The infective agent in chancroid is the Bacillus of Ducrey.

The Bacillus of Ducrey is a short, thick bacillus with rounded ends, somewhat like a dumb-bell. It is about 1½ micromillimeters in length. It is found both within the cells and between them.

The specimen is taken on a slide and prepared in the usual way, and then stained for one half hour in the following solution:

Sol. acid boric five per cent .... ℥ss;
Sat. sol. methylene-blue aqueous .... ʒv;
Distilled water .... ʒvj.

It is sometimes very difficult to demonstrate the bacillus in stained specimens, owing to the extremely small number compared to the enormous numbers of other bacteria present.

Acute Gonococcal or Specific Urethritis.—This condition is the most frequent cause of urethral discharge. The constituents of the discharge are mucus, epithelial cells, pus cells and diplococci, which are the infective agents called gonococci. Other germs existing normally in the urethra or complicating the original infection may be present.

At the onset of the disease, the discharge is mucoid or muco-purulent, appearing as a slight moisture or a drop at the meatus when the gonococcal invasion has as yet not penetrated farther than the fossa navicularis. If very acute or moderately acute, the discharge becomes more abundant, purulent or muco-sanguinolent, and the gonococcus is found in the discharge. The characteristic discharge of acute urethritis contains but very few epithelia as compared to the enormous number of pus cells present. As the acute infection begins to subside and as a proliferation of epithelia goes on in the process of healing, the number of epithelial cells in the discharge grows larger, while the relative number of pus cells is less. Thus we are able to gauge with fair accuracy by the microscopical examinations, the acuteness of the urethritis, by the number of epithelia as compared with the number of pus cells. An exception must be noted, however, during the first few hours of an acute attack when the discharge is mucoid and when there are more epithelia than pus cells, the epithelia coming largely from the anterior region of the canal, that is, of the large, flat type, irregular or polygonal in shape. Gonococci are present until the discharge has ceased or is a simple moisture.

Chronic Gonococcal Urethritis.—The discharge of chronic urethritis differs from that of the acute conditions in that it is scanty, mucoid or muco-purulent, sometimes absent during the day, but present in the morning. It contains mucus, urethral epithelia, especially many squamous cells and usually but a small amount of pus. Gonococci are usually, but not always, found.

Gonococci are coffee-bean-shaped micrococci, grouped in pairs, the flattened surfaces facing each other. For this reason the gonococcus is generally spoken of as diplococcus. It is usually found in the pus cells, that is, intra-cellular, occupying the protoplasm, but never penetrating the nuclei. It stains deeply with anilin dyes and can readily be distinguished upon the paler background

of the pus cells or epithelia. Examined under high magnifications, the longitudinal slit between the two cocci constituting the pair, can be very distinctly made out.

The gonococcus varies somewhat in size, the average being 1.25 microns in length and from 0.6 to 0.8 microns in diameter. The well-developed and full-sized germ is found in acute conditions, while in some chronic cases, the smaller form may sometimes be seen, showing possibly an attenuated state. A variety of sizes may be noted in some pure cultures.

The pairs of cocci are grouped usually in small masses; occasionally, however, a cell will contain but a few pairs. In acute urethritis, on the other hand, when the process is virulent, numerous pus cells will be found so closely packed with gonococci, that the cell protoplasm is entirely masked. Often, also, the gonococci are found grouped about the nuclei of a cell, but the cell body seems to be absent, because it is either very faintly stained or has been obliterated in the course of the inflammatory process. When epithelial cells occur in the urethral discharge, the gonococci are often grouped about them or seem to lie upon the cells or within them. The intra-cellular position of the gonococcus in the pus cells, however, is so characteristic, that its recognition is made a condition for the morphological diagnosis of this germ.

The important part of the examination of the discharge in gonococcal infection is naturally for the gonococcus. The number of gonococci found in a specimen of gonorrheal pus varies greatly, according to the stage of the disease and the virulence of the infection. There is also a variation in the number of gonococci found within the pus cells in different stages of the inflammation. They are most numerous in the creamy discharge.

A large number of other cocci and bacilli are also found in some cases of gonorrheal urethritis (secondary infection). It is said that when these are present, complications are more apt to occur.

In chronic cases accompanied by very little mucoid discharge and by some shreds in the urine, it is difficult and sometimes impossible to detect gonococci either in the discharge emitted in the morning (morning drop), in the shreds or in the urine.

In cases of relapse or of exacerbations of a chronic gonorrhea, the gonococci reappear, although occasionally they are not found.

Methods of Staining and Examination.—The first step in this examination is the fixation of the smear upon the slide by means of heat. This is done by taking the slide between the thumb and forefinger and passing it slowly, smear side up, three times through the flames of an alcohol lamp. The next step is to stain the smear with one of the anilin dyes, which suffices in routine work. In case of doubt as to the identity of the germ, it can be determined by Gram's stain. It is advisable, in important cases, to take several smears, so as to have material for confirmatory examinations.

The gonococcus stains readily with the basic anilin dyes, but loses its color when treated with Gram's method—in other words, it is Gram-negative.

1. *Methylene Blue.*—A great variety of staining methods have been used for staining the gonococcus. The simplest method, which at the same time is perfectly satisfactory for ordinary clinical work, is with a dilute solution of methylene blue, which is dropped upon the smear by a medicine dropper in sufficient quantity to cover the slide and allowed to remain for five minutes; it is then washed thoroughly with distilled water. Such is the differentiating action of this basic dye, that the nuclei of the cells are stained a pale blue, while the cell bodies are stained a still paler tint, forming a background against which the gonococci appear distinctly. If the preparation has been carefully and thinly spread, if the light and the optical conditions are perfect, the morphology of the germ appears sharply defined with this method of staining. (The formula for the methylene-blue solution is a matter of individual choice.)

2. *Gram's Differential Method.*—The most important method of differentiating the gonococcus from other germs which resemble it, and which may occur in urethral discharges, is the method of Gram, to which reference has already been made above. This method consists in treating the smears with a staining solution known as "anilin water gentian violet."

The anilin water is dropped on the fixed smear in the same way as the methylene blue and allowed to remain five minutes. It is then transferred to Gram's solution (composed of 1 gram of iodin, 2 grams of potassium iodid, and 300 c.c. distilled water), in which it remains for about two minutes. It is next rinsed thoroughly in absolute alcohol until no trace of violet can be seen. If there is still some violet color, the iodin solution is again used, followed by rinsing in alcohol, and this is repeated until no trace of violet is visible. The specimen is next washed in water, and then counterstained for about two minutes in a solution of 1 part of Bismarck brown, 10 parts of alcohol and 100 parts of distilled water. The specimens are then dried and examined with the oil-immersion lens.

The characteristic feature of the gonococcus in specimens thus stained is that it loses its color when treated with the decolorizing solution of Gram, and takes the brown counter stain.

The other bacteria in the preparation, including other diplococci, which may resemble the gonococcus, retain the purple color of the gentian violet. Gram's method is, therefore, useful in the diagnosis of the gonococcus in smears. It should be employed whenever there is any doubt as to the identity of a diplococcus found in urethral discharges, especially in medico-legal investigation.

Chronic Prostatitis.—Chronic prostatitis is an inflammation of the prostate usually following gonorrhea or some other urethral infection. The discharge is generally seen in the morning, having passed the cut-off muscle dur-

CHARACTERISTICS OF DISCHARGES FROM THE MALE GENITO-URINARY TRACT

	Character.	Epithelium.	Corpuscles.	Mucus.	Bacteria.	Spermatozoa.	Amyloid bodies.	Böttcher's crystals.	Connective tissue.
Urethrorrhea.	Clear. Viscid. White.	Superficial. Urethral.	Mucous corpuscles.	Mucus.	No gonococci.	—	—	—	—
Prostatorrhea.	Thick. Viscid. White.	Prostatic. Urethral.	Few leucocytes.	Mucus.	No gonococci.	Few or none.	Present.	Present.	—
Spermatorrhea.	Thick. Viscid. Turbid.	Prostatic. Urethral. Epididymis. Seminal vesicles. Cowper's glands.	Mucus. Few leucocytes. Lecithin corpuscles.	Mucus.	—	Numerous.	May or may not.	—	—
Nonspecific urethritis.	Scanty, thin, mucoid or profuse, thick yellow purulent.	Urethral.	Pus. Red blood, sometimes.	Mucus.	Saprophytes. Staphylococcus. Colon bacillus. Streptococcus from leucorrheal discharge.	—	—	—	—
Tubercular urethritis.	Scanty mucoid or yellow purulent.	Urethral.	Pus. Red blood, sometimes.	Mucus.	Tubercle bacilli Other organisms Cocci and bacilli	—	—	—	Sometimes.
Syphilitic urethritis.	Scanty, thin, sometimes profuse muco-purulent; sero-sanguineous; puro-sanguineous.	Urethral.	Pus. Red blood, sometimes.	Mucus.	Spirochete.	—	—	—	Sometimes.

	Character.	Epithelium.	Corpuscles.	Mucus.	Bacteria.	Spermatozoa.	Amyloid bodies.	Böttcher's crystals.	Connective tissue.
CHANCROIDAL URETHRITIS.	Profuse. Purulent. Purosanguinolent.	Urethral.	Pus. Red blood, sometimes.	Mucus.	Bacillus of Ducrey. Other pus-producing organisms.	—	—	—	Sometimes or absent.
ACUTE GONORRHEAL URETHRITIS: ANTERIOR-POSTERIOR.	Scanty—thin mucoid. Copious—thick, yellowish green. Purosanguinolent.	Squamous, round. Cylindrical, cuboidal.	Few pus at first. Later many. Red blood in very acute stage.	Mucus.	Gonococci.	—	—	—	At times or absent.
CHRONIC GONORRHEAL URETHRITIS.	Scanty muco-purulent.	Many squamous. Few round. Few cylindrical. Few cuboidal.	Pus.	Mucus.	Gonococci.	—	—	—	—
CHRONIC PROSTATITIS.	Scanty. Thick. Viscid.	Prostatic. Urethral.	Pus.	Mucus.	Gonococci at times.	Few at times.	Present.	Present.	—
CHRONIC VESICULITIS.	Scanty. Viscid.	Urethral. Vesicular. Prostatic.	Pus.	Mucus and colloid material.	Gonococci at times.	Spermatozoa at times. Many disintegrated.	—	—	—

ing morning erections, as in prostatorrhea. The discharge is similar to that of prostatorrhea, plus pus and infection. It is scanty and viscid, and contains prostatic and urethral epithelia, leucocytes (pus), mucus, few or no spermatozoa, amyloid bodies and Böttcher's crystals, gonococci or other bacteria.

Chronic Vesiculitis.—Chronic vesiculitis is an inflammation of the seminal vesicles, due to gonorrheal or other infection. The discharge is scanty and viscid, and resembles that of spermatorrhea. It contains urethral, vesicular and frequently prostatic epithelia, pus corpuscles, mucous and colloid material, gonococci or other microörganisms, usually many spermatozoa, well developed and in different stages of disintegration. The condition is characterized by the discharge oozing out in nocturnal erections, the same as in prostatitis.

DISCHARGES IN THE FEMALE

In men the discharges come from the meatus, as the urogenital canal commences in the prostatic urethra, where the secretions of the prostate and those coming from the ejaculatory ducts first meet the urinary flow. From here to the external meatus, the genital and urinary tract are in common. In women, the urinary and genital tracts first meet at the vulva and therefore the discharges from the urinary and genital tracts would reach this point in case they are sufficiently profuse.

A discharge found on the vulva may come from the vulva itself, the urethra, Skene's glands, the glands of Bartholin, the vagina, the cervical or uterine canals or the Fallopian tubes, under the following conditions: Nonspecific urethritis, acute gonococcal urethritis, chronic gonococcal urethritis, gonorrhea of Skene's glands, Bartholinitis, nongonococcal, gonococcal, tubercular, syphilitic and malignant disease of the vagina, chancroids, in endocervicitis or endometritis due to nongonococcal or gonococcal infection or to tumors, benign or malignant, tuberculosis or salpingitis.

A smear should be taken from the vulva by touching it with a glass slide. This smear may, therefore, contain a combination of discharges from various points, consisting of mucus, pus and blood cells, epithelia from the mucous membrane of the vulva, urethra, vagina, glands of Bartholin, uterus and the Fallopian tubes; also gonococci and various other cocci and bacilli.

The vulva should then be wiped with a piece of moist gauze and the discharges from the various other contributing parts should be taken in the manner previously described.

Urethral discharges occur in gonococcal and nongonococcal inflammations, just as in the male. The appearance varies from a thin, scanty, transparent or turbid drop to a thick yellow or greenish-yellow discharge. In nonspecific inflammations, microscopic examination shows mucus, pus cells, urethral epi-

thelium and the various kinds of cocci and bacilli normally present in the urethra. Blood cells may also be present, but no gonococci.

The gonorrheal discharge from the urethra differs only on account of the relatively greater number of pus cells, plus gonococci, both intra- and extra-cellular. In chronic gonococcal urethritis, the discharge is often very scanty or absent, in which case a specimen should be obtained by introducing a platinum wire into the urethra. Skene's glands should then be pressed upon and any discharge coming from them should be taken. Very often in latent cases these glands harbor gonococci.

Discharges due to chancre or chancroid are the same as in the male, and have to be determined by the presence of the Spirocheta or the Bacillus of Ducrey. Bartholin's glands should next be gently squeezed, and the discharge from their ducts examined. Bartholinitis is due in nearly all cases to gonorrheal inflammation, and the microscopic examination of the discharge shows mucus, pus cells, columnar epithelium from the gland's duct and gonococci, both intra- and extra-cellular.

The discharge coming from the vagina is then examined. This may come from the vagina itself or from the cervix, uterine canal or the Fallopian tubes. This discharge is known as leucorrhea, although the gynecologist in whose field it belongs, seems to use the name less than formerly. A speculum is inserted into the vagina and the sides of its walls explored. The vaginal discharge is usually thin and creamy, although in chronic cases, it may be thick and adherent. The examination may also show a chancre, chancroid, tuberculosis, cancer or an inflammation due to gonococcal or other infection. Smears or scrapings are taken and the microscopical examination is made as already described in the first part of the chapter.

The cervix is then examined for lacerations or malignancy. If there are no evidences of either of these conditions, but a thick opaque discharge, white or yellow in character, is seen coming from the cervical canal, the patient has an endocervicitis due to a gonococcal or other infection; whereas, if it is very purulent, it probably comes from the tubes. In case it is due to a gonorrheal process, gonococci are present. If they are not present, it is due to some other infection, and has as a predisposing cause uterine displacement, or subinvolution or new growth. Besides mucus, pus and the germs of infection, the discharge from the uterus occasionally contains ciliated epithelia.

CHAPTER V

THE BLOOD IN RELATION TO UROLOGY

Blood examinations are especially useful in differentiating septic or suppurative conditions from other fevers, as, for example, typhoid or malarial fever. They also give a clew as to the degree of resistance to be expected from an anemic patient before operation; while blood counts, periodically made after operations, show us the progress of our patients on the road to recovery. The degree of coagulability of the blood, determined before operation, gives us confidence to operate in certain cases, while it warns us not to in certain grave conditions of the kidneys or the prostate.

In this brief chapter I shall confine myself to those clinical facts which should be known in order to interpret properly the blood examinations furnished by the laboratory.

Blood comprises a fluid, liquor sanguinis or plasma, in which float certain specialized cellular bodies known as corpuscles. The plasma is a solution of various salts and of proteid materials (fibrinogen, serum albumin, serum globulin), and is the fluid medium which acts as a recipient and carrier of metabolic, eliminative and nutritive substances.

The Percentage of Hemoglobin.—In healthy men, the percentage of hemoglobin is from eighty-five to ninety-five per cent. In robust persons, it may, however, reach above one hundred per cent. A percentage below eighty-five per cent indicates anemia. The determination of the hemoglobin percentage is a most important feature in blood examinations in both general and urological surgery. All chronic surgical conditions generally produce some secondary anemia, which grows more profound as the case progresses. This is especially so in septic conditions and in malignant growths. In this secondary anemia, the decrease in the hemoglobin percentage is the first change noted in the blood, except in septic conditions, and frequently the hemoglobin is diminished in disproportion to the comparatively slow or moderate decrease in the blood cells.

Corpuscles.—The corpuscular elements of the blood are divided into three classes: (1) The red blood cells, or erythrocytes; (2) the white cells, or leucocytes and (3) the blood platelets. Other minute particles of irregular-shaped bodies, known as blood dust or hemokonia, will not be considered.

Blood Count.—The blood count means determining by count the number of red and white blood cells contained in a cubic millimeter of blood.

The Red Cells.—The normal number of red cells is 5,000,000 to the cubic millimeter of blood in men and 4,500,000 in women. They contain about ninety per cent of oxyhemoglobin and a small amount of nucleo-proteid. Their function is to carry oxygen from the lungs to the tissues in loose combination with hemoglobin.

Leucocytes.—The white cells or leucocytes in fresh blood appear as colorless, highly refractive bodies, containing one or more nuclei, and sometimes granular matter in their cell bodies. They number from 5,000 to 10,000 to the cubic millimeter, an average being 7,500. A differential blood count means an estimation of the percentage of the different white cells, which is of great importance in urological diagnosis. The four varieties of leucocytes found (Ehrlich) are:

(1) Small mononuclear leucocytes—lymphocytes, twenty-two to twenty-five per cent.

(2) Large mononuclear and transitional leucocytes, two to four per cent.

(3) Polynuclear (neutrophile) leucocytes, seventy to seventy-two per cent.

(4) Eosinophile (polynuclear or bilobed nuclei) leucocytes, two to four per cent.

Blood plaques and blood dust need no mention here, as they are not of interest in surgical conditions.

Leucocytosis.—When the number of leucocytes is markedly increased, we have a *leucocytosis*. *Simple leucocytosis* affects chiefly the polynuclear leucocytes and is sometimes styled "polynuclear leucocytosis." When the lymphocytes (small mononuclear) are increased, the term "lymphocytosis" is used. When the eosinophile cells are increased we speak of "eosinophilia," and when several varieties of leucocytes are increased, we have a "mixed leucocytosis." A *physiological leucocytosis* may occur in pregnancy, during digestion, after exercise, hot or cold baths, massage or electric treatment.

A moderate leucocytosis means from 10,000 to 15,000; a marked leucocytosis from 20,000 to 25,000; and a very marked one may reach 85,000 or even 90,000.

Leucocytosis in disease may be temporary in acute and permanent in chronic conditions.

Inflammatory leucocytosis is the infective type. The theory of this is, that, when infectious agents (bacteria, etc.) enter the system, they generate chemical substances which have the property of attracting leucocytes into the blood out of their hiding places in the spleen, the marrow, etc. In addition, however, the influence of germs seems to favor the formation of new leucocytes in the marrow, spleen and lymphatic glands, and it is from these sources that we have leucocytosis in the blood—emigrated and newly formed leucocytes.

LEUCOCYTOSIS AND INFECTIOUS DISEASES.—The importance of leucocytosis in an infectious process can be realized when we consider that the leucocytes attack bacteria and engulf them within their protoplasm, where the germs are digested by a special ferment or killed by a bactericidal substance which exists in the white cells. The leucocytes are, therefore, the body's army of defense, sent out to annihilate the enemy, which is the germ, and this process is called *phagocytosis.* Blood serum and lymph also contain bactericidal substances which take part in the fight against the germs and their poisons.

A person with strong resistance to infection will develop a marked leucocytosis when a virulent germ enters the system. A person with poor resistance, on the other hand, will have a slight or no leucocytosis when the same germ enters. In a person with good resistance, even a mild infection will produce moderate leucocytosis. We see at once how leucocytosis may be employed to gauge the constitution of the patient in a septic case before a serious operation.

The importance of blood examination is shown in the following diseases, occurring in or with diseases of the urinary tract:

Septicemia,	Malaria,	No leucocytosis,
Tuberculosis,	Syphilis,	
Gonorrheal Infection,	Hemorrhage,	
Peritonitis,	Malignant Growths.	

(*a*) *Septicemia.*—In septicemia, patients with a slight resistance to infection have no leucocytosis. The prognosis of those cases is, as a rule, unfavorable. In most patients, however, there is a distinct *polynuclear leucocytosis.* The prevalence of polynuclear cells in septicemia, in fact in any septic condition, serves to differentiate these affections from typhoid fever, where the whole number of polynuclear leucocytes is *diminished,* but the lymphocytes are markedly increased. When typhoid is complicated by suppurative conditions, this rule does not hold good and a leucocytosis is present. In such cases, one must rely upon the Widal test.

(*b*) *Tuberculosis.*—In tuberculosis, no inflammatory leucocytosis results unless a mixed infection is present, when a polynuclear leucocytosis occurs.

(*c*) *Gonorrheal Infection.*—In gonorrheal infection, a moderate leucocytosis of the polynuclear type is found, especially in acute gonorrhea when accompanied by fever and complicated by epididymitis, orchitis, etc. The gonococcus can be isolated from the blood in gonorrheal endocarditis and other gonorrheal metastases.

(*d*) *Peritonitis.*—All forms of peritonitis, except the tuberculous, produce a leucocytosis, unless the patient is very weak. A sudden rise in the number of leucocytes indicates a spread of the process. Chronic cases are associated with increasing anemia.

(*e*) *Cachectic Leucocytosis.*—In malignant tumors there is leucocytosis which becomes more marked as the disease advances, and which is due to the local inflammation (that is, ulceration and necrosis) and the chronic toxemia. The blood is usually normal in the early stages. A profound anemia with a distinct leucocytosis follows later, due to toxemia. Usually the ratio of the polynuclear cells is increased, but occasionally there is an increase in the mononuclears, or myelocytes may be present. The anemia becomes profound as the cachexia advances. In some cases of sarcoma, there is a marked lymphocytosis, the blood looking like that of lymphatic leukemia.

(*f*) *Posthemorrhagic Leucocytosis.*—Great loss of blood is followed by a marked increase in the white cells. This leucocytosis rapidly disappears before the red cells reach their normal level and is due to the pouring in of the lymph to take the place of the lost blood.

The Degree of Coagulability.—The degree of coagulability of the blood is of great interest to the surgeon. In urology, it is of special importance in cases of tumor of the bladder and kidney, and also when such operations as prostatectomy and nephrectomy are contemplated, where much bleeding and oozing may be expected. Roughly stated, the blood normally clots within five minutes. If the clotting is delayed to ten or fifteen minutes, one may look for a dangerous oozing or hemorrhage in the patient. A number of conditions, chief among them hemophilia, purpura and jaundice (cholemia), produce a deficient coagulability. Wright's coagulometer is an instrument used to measure this physical property of the blood. If the coagulability is found deficient, the usual treatment with calcium chlorid, gelatin, etc., may be employed.

Bacteria in the Blood.—The discovery of specific bacteria in the blood is not an easy matter, and requires the most rigid aseptic technique and the utmost watchfulness and skill in the preparation and use of the various media. But few germs occur in the blood in such numbers that they can be detected in ordinary smears. The principal microörganisms which are found in the blood are:

(1) *Streptococcus and Staphylococcus.*—In septic conditions, malignant endocarditis, etc., their presence in the blood always means a bad prognosis, but care must be taken to exclude accidental contamination by the Staphylococcus albus always present in the skin.

(2) *Tubercle Bacilli.*—This has been found in the blood in acute miliary tuberculosis and is difficult to detect, but it exists probably oftener than is supposed.

(3) *Gonococcus.*—The gonococcus has been isolated from the blood in a number of cases, principally in malignant endocarditis due to gonorrheal infection.

(4) *Bacillus Coli.*—The bacillus coli can be often detected in the blood in some form of septicemia in urological cases.

(5) *Typhoid Bacillus.*—Typhoid bacillus is always present in the blood in typhoid fever and is not difficult to detect.

An important point to remember is that the *absence* of a germ from the blood is not to be regarded as a negative diagnostic factor.

(6) *Protozoa in the Blood.*—Among these are the Plasmodia malariæ and the embryos of Filaria sanguinis and the spirilla of European and African recurrent fever.

CHAPTER VI

UROLOGICAL EQUIPMENT

In considering urological equipment, we will discuss the space that the physician uses for his office work, his office furniture, apparatus, instruments and dressings. In case he has a clinic or hospital service, it should also be taken into consideration. The methods of conducting his private and institutional work should also be spoken of.

Space Required for Office Work.—In order to do good work in urology, it is not necessary to have an elaborate plant; efficient urological work can be done and is done in a very limited space.

This usually consists of one room in which the patients wait, called a reception room, and another in which to attend them, called the office, situated

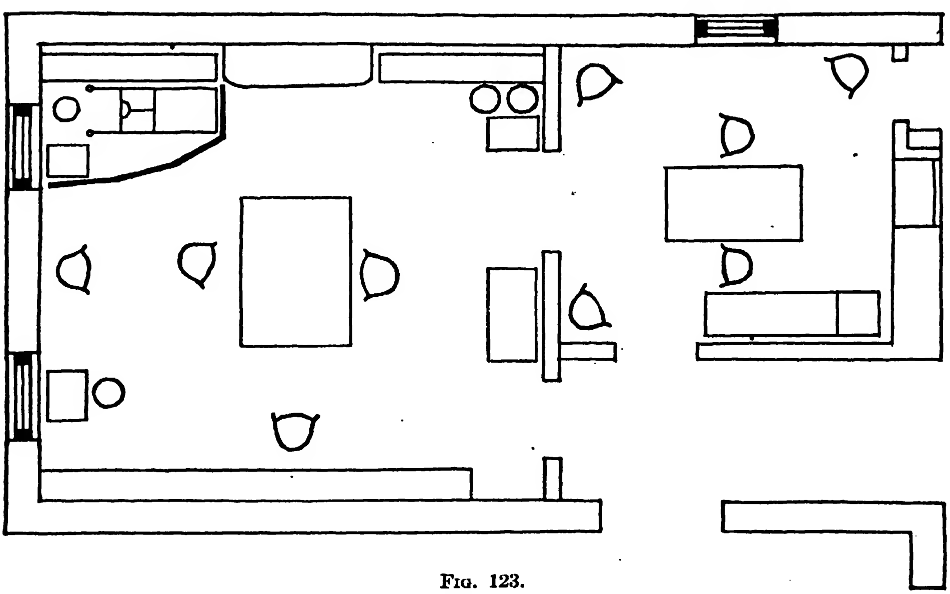


Fig. 123.

on the same floor. The office proper, in case it consists of but one room, is a combined consultation and treatment room. Such was my office for many years. (See Fig. 123.)

Here it will be seen that the waiting room faced the patient on entering, while the office opened into the hall on the left. The office was a large one, having two windows facing the street, on the opposite side to which were two doors, one opening into the hall, the other into the waiting room. The two remaining sides of the room with their corners were used for my library and equipment.

On the side of the room extending from the hall door to the front, was an open bookcase with hanging curtains on the shelves. In the corner of this, near the adjacent window, was placed my microscope with its accessories.

On the opposite side of the room, was the fireplace in the center and a cabinet with shelves, resembling a bookcase, extending from it to the wall on either side. The space between the fireplace and the window contained everything required in the office for urological work—the examining table, the instrument table and an open cabinet on the shelves of which were all the apparatus, instruments and dressings used for the examination and treatment of patients. In a corner corresponding to the space between the fireplace and the reception-room door, was kept my sterilizing and throat apparatus. The fourth corner was unavailable on account of the presence of the hall door.

In my one-room office, everything that was used for my microscopical and throat examinations was kept on the shelves of the bookcase or cabinet and just before office hours was placed on the tables in the corners, ready for use; and they were put away again after office hours. The corner where the examining and instrument tables and the urological apparatus and instruments

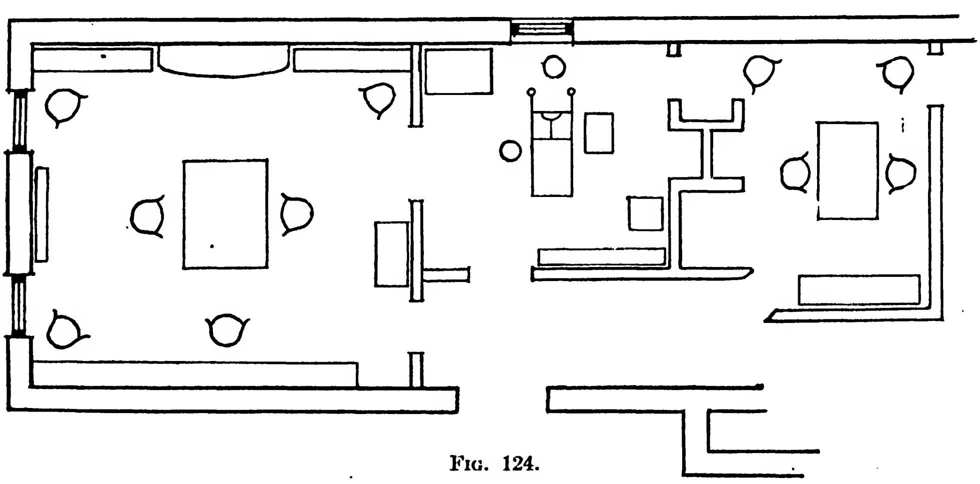


Fig. 124.

were kept, was hidden by a screen. Within a few minutes, this room was transformed from a library into an office and vice versa twice a day. Everything pertaining to my work was kept in this one room and there was no running about, no looking for things that were in some other room. The only disad-

vantage of this limited space was that I could only do a certain amount of work in the time allotted to office hours.

In the course of time it became necessary to add more space. The first step was to convert the adjoining reception room into a treatment room and to place in it a similar equipment to that which I already had in my single office behind the screen. I took an adjoining room for my patients to wait in, thus making a consultation, treatment and reception room. (See Fig. 124.) This enabled me to have a patient in the consultation room and another in the treatment room at the same time. It also permitted me to have an assistant to handle the old cases while I was examining the new ones.

As my practice increased, I added another room as a laboratory, thus making a complete suite of offices. (See Fig. 125.)

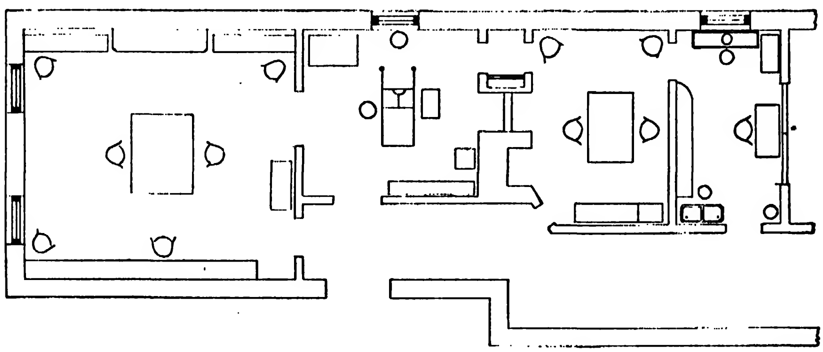


FIG. 125.

Office Furniture.—The consultation room in a urological office can be furnished in any way that the practitioner desires, but it is desirable to have strong, heavy furniture, preferably of a dark color, covered with leather. It should consist of a table-desk, a number of chairs and a couch; also a bookcase, if it contains the library. Besides this, if the patients are to be treated in the same room, it should have additional office furniture indicated for a one-room office, such as an examining table for the examination and treatment of patients; an instrument table; a small table for microscope, or for whatever other purpose the practitioner might desire; a cabinet for apparatus and instruments and a lamp—electric or gas (probably both). Small stools and tables are always convenient and take up but little space.

Apparatus and Instruments Recommended for Office.—TABLES.—For examination and treatment of patients; for instruments; for microscope and accessories.

LAMP.—With a reflector—electric, gas or oil.

STERILIZER.—Steam, formalin, a pan for boiling instruments.

RUBBER GOODS.—Rubber tubing for irrigating jars; hard-rubber irrigating tips, shields and cut-offs; finger cots.

GLASSWARE.—Irrigating jars; jars for dressings; jars for solutions; glass graduates; urine tubes; medicine droppers.

GRANITEWARE.—Basins for solutions; douche pan; pus basin.

PISTON SYRINGES.—Large and small urethral; bladder; hypodermic.

DRESSINGS.—Assorted bandages; T-bandages; cotton balls; tampons; sanitary pads; gauze compresses—3 by 5; 5 by 6; 8 by 10; gauze compresses with cotton-combined dressings—5 by 6; 8 by 10; adhesive plaster.

MISCELLANEOUS.—Instrument tray; galvanic and faradic battery; small water barrel (for hot water); tub for bichlorid solution in which to sterilize utensils requiring chemical disinfection; stirrups and lithotomy uprights for examination and treatment tables.

Cocain tablets; bichlorid tablets; peroxid; Holzien solution; silver solution; boric acid; alcohol; lubricants (glycerin, gonmenol); green soap; brushes.

INSTRUMENTS.—*Special.*—Catheters—*soft rubber,* straight or elbowed; *woven,* straight with olivary tip and elbowed; metal.

Filiform bougies; bougies à boule.
Sounds.
Stone searcher.
Dilators—Kollmann and Oberländer.
Urethroscope.
Cystoscope.
Prostatic douche tubes.
Instillating syringe.
Applicators.
Tunneled sound and catheters.

Perineal grooved probe, director, cannula and gorget; perineal drainage tube.

Rectal bag.

Prostatic forceps and depressor.

General.—Retractors, dull with rounded edge, large and small; sharp with short teeth.

Probe, grooved director.

Scissors, dull curved, sharp curved; dull straight.

Knives, straight scalpels, large and small; straight and curved bistouries.

Needles, large and small Hagedorn's, short round, surgical and straight.

Needle holder.

Forceps, thumb; artery, curved with long slender blades; bullet.

Sponge forceps.

Vaginal speculum, depressor, dressing forceps.

Throat mirror and tongue depressor.

Sutures, ligature material, catgut plain and chromic, Nos. 1, 2 and 3; braided silk.

Ligature carrier.

Kelly pad.

Paquelin cautery.

Extra Equipment for Outside Work.—Besides the office equipment, little is needed for outside visits. The following list will show what is generally used for operations and cystoscopy outside of the office.

BAGS FOR OUTSIDE WORK

For Cystoscopy

Rheostat.
Two cystoscopes and cords.
Bougies à boule; sounds.
Assorted catheters.
Syringes { Bladder. / Urethral. / Fountain.
Glycerin.
Test glass.
Cocain solution.
Bichlorid tablets.
Silver solution.
Medicine dropper.
Rubber tubing.
Suppositories of morphin and quinin.
Kelly pad.
Rubber sheeting.
Table and lithotomy leg rest.
Sterilized towels.
Cotton balls.
Gauze pads.
Battery, if no electric light.

For Operation

Portable metal table.
Rubber sheeting and Kelly pad.
Basins.
Sterilized towels.
Green-soap tincture.
Brushes and nail file.
Alcohol.
Bichlorid tablets.
Syringes { Fountain and piston. / Hypodermic.
Assorted catheters, knives, scissors.
Lubricant.
Cocain.
Peroxid.
Forceps { Thumb. / Artery. / Sponge. / Bullet. / Prostatic.
Assorted retractors.
Assorted needles.
Needle holder.
Sutures and Ligatures } Catgut { Plain. / Chromic. ; Braided Silk.
Sounds.
Bougies à boule.
Gouley tunneled sound and catheter
Filiforms.
Urethrotomes { Otis. / Maisonneuve.
Perineal { Grooved probe. / Grooved director. / Grooved cannula. / Gorget.
Bandages, assorted dressings.
Large catheter drain tubes.
Portable sterilizer.
Pedicle clamp.
Infusion jars.

Office Dressing Equipment.—Towels.—A large supply of office towels, 18 by 36 in size, must be kept on hand. The variety known as "glass" towels are the best for general use. They are kept wrapped in an outer towel, or preferably in a piece of muslin, in packages of ten for office work and six for outside operating. The packages of towels should be kept in a tin box as stock.

Cotton Balls.—These are convenient in office work for sponging the meatus and glans in men, and the vulva, meatus and vagina in women, before instrumentation. They are kept in glass jars on a treatment table. Before using, they should be dipped into a bichlorid solution, which should always be kept in a jar close at hand. The solution should be changed daily.

Gauze.—This is a most useful surgical dressing, and much care should be given to its preparation and sterilization. The following varieties of gauze dressings are useful. They should be kept in separate jars and a supply should be in each room, while a sufficient supply should be kept in tin boxes for office and outside work.

Gauze sponges, 3 by 6 inches, for absorbing blood, etc., during an operation and for use with probangs or sponge holders, are folded from pieces of gauze 9 by 16 inches. They are also useful unfolded to wrap about the forefinger in making a rectal examination.

Sponges or compresses, 5 by 6 inches, are made of pieces of gauze, 15 by 18 inches, folded three times each way, with the cut edges inside. They can be stitched at their free borders or left free as the surgeon prefers. They are packed in tiers in jars, or are tied up in packages containing four pads each, wrapped and pinned in pieces of muslin. Some of these packages may contain in addition a number of cotton balls, as these are better adapted for use in a minor operation.

Large gauze compresses for abdominal pads are gauze pieces, 18 by 24 inches, folded to make pads, 6 by 8 inches. For abdominal sponges these gauze pads should have their edges sewed and provided with tapes.

Gauze packing strips should be an inch wide and three yards long. A thread is pulled from a piece of gauze of this length and the strip is cut along the line indicated. These strips are kept in eight-inch tubes plugged with cotton, the tubes being in turn kept in jars. When the dressing is needed, it is pulled out with sterile forceps and cut with sterile scissors.

Strips of gauze, an inch wide and a yard long, saturated with five- or ten-per-cent iodoform and others of the same size, saturated with Balsam of Peru, are also kept in stock for packing wounds.

Other Dressings.—Bandages, both gauze and muslin, from 1 to 4 inches wide, are used for office work and outside operating. They can be wrapped in sets of from two to four in pieces of muslin.

Rubber tissue in assorted sizes is scrubbed with green soap and is kept in 1:500 solution of bichlorid.

Surgical plaster (diachylon or zinc oxid) is kept in convenient rolls. For small dressings, pieces of diachylon plaster, 1 inch wide by 4 to 6 inches long, are kept in readiness in a small jar and are known as dressing holders. They are heated for a moment over an alcohol lamp before being applied. Ordinary adhesive plaster is used for strapping on dressings of large size.

Forceps for taking dressings and gauze out of jars and tubes are sterilized by dipping into pure carbolic and alcohol, or are kept, during office hours, in a glass jar containing five-per-cent carbolic.

Glass hand syringes, irrigator tips and shields, couplings of glass or hard rubber are kept on the treatment table in alcohol or bichlorid solution. *Infusion jars* are rarely used in office work, but they are an important part of the outfit for an outside operation and should be provided with a thermometer.

Needles, threaded with silk or unthreaded, are put through pads of gauze in assorted sizes and varieties. The pads with their needles are wrapped in small pieces of muslin and sterilized by dry heat or formaldehyd. The packages are thus ready for operations. Ordinarily, needles of assorted sizes are kept in covered glass dishes containing a mixed powder of boracic acid and lycopodium. The suture material is all kept in tubes ready for use.

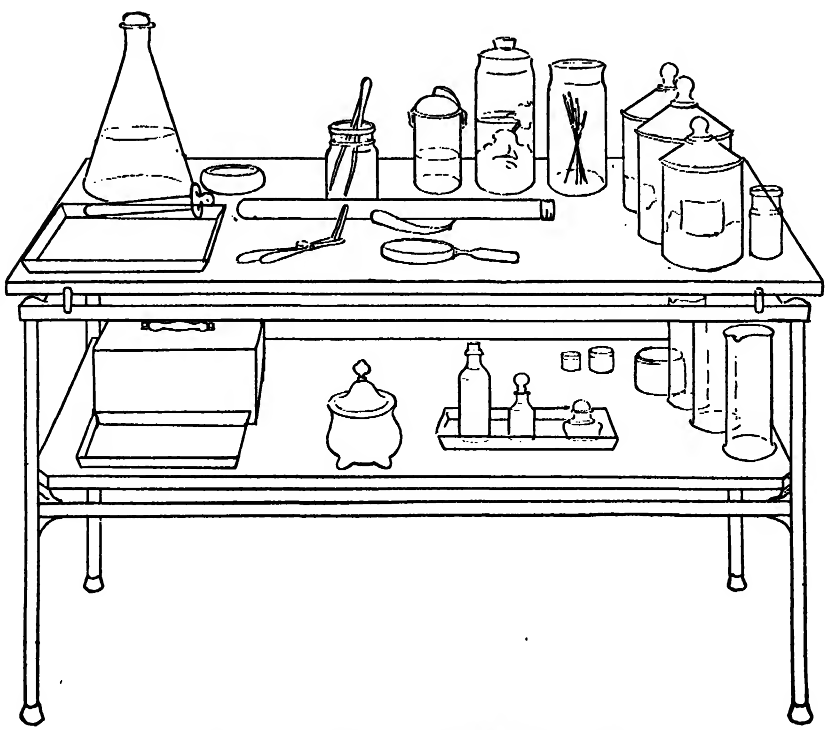


Fig. 126.—Table in the Examining Room.

On the top are kept in jars, gauze cotton balls, lubricants, syringes in alcohol, applicators, catheters, urethral speculum, sterile water, magnifying glass. On the lower shelf, urine cylinders, finger cots, vaseline, material for quick urinary tests, two dishes, and cases for instruments.

Hypodermic syringes are kept with their needles, etc., in a small glass tray. The needles should always have wires in them when not in use.

Arrangement of Author's Present Offices.—In arranging my rooms for office work, it was necessary for me to convert the basement, situated immediately under my consultation room, into a reception room. This was easily done and it was connected with the offices and treatment rooms above by a private staircase. The arrangement of the office floor still remains as it was then planned.

Room No. 1 is the consultation room, containing bookcases for the larger part of the library, a table, a desk, a letter file, two easy chairs, two armchairs, two ordinary chairs and a couch. It opens into the examining room (No. 2) by one door and into the hall by another.

Room No. 2, the first examining and treatment room, is painted and furnished entirely in white. It contains an examining table, an instrument table (Fig. 126), a tray table, two stools, a chair, a commode, a screen and a cabinet for apparatus and instruments.

The examining table is of the counterbalance variety, with a drain pan below (Fig. 127). The seat section of this table, on which the buttocks of the

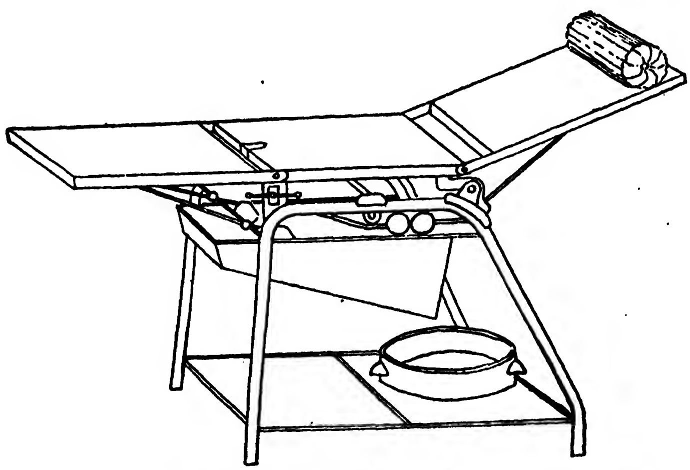


Fig. 127.—Author's Counterbalance Table in the Position for Examination of Male Patients.

patient rest, is made of two pieces of glass with a slit between them, which allows the fluids used in treatment to drain into the pan. The head or back section can be raised to any position (Fig. 128) for facilitating the examination of the abdomen, or increasing the comfort of the patient; while the leg part of the table, for supporting the lower extremities, can be removed and the hip portion elevated for cystoscopy. With the leg section removed, this table makes an ideal table for treating women, as the solutions run into the pan below. Care must be taken, however, to see that the patient, when lying on the table,

sits on the middle part first, as seating oneself on either of the end pieces might result in falling to the floor. The patient must also be instructed in moving about on the table to take hold of the side bars, as, if the top of the table is

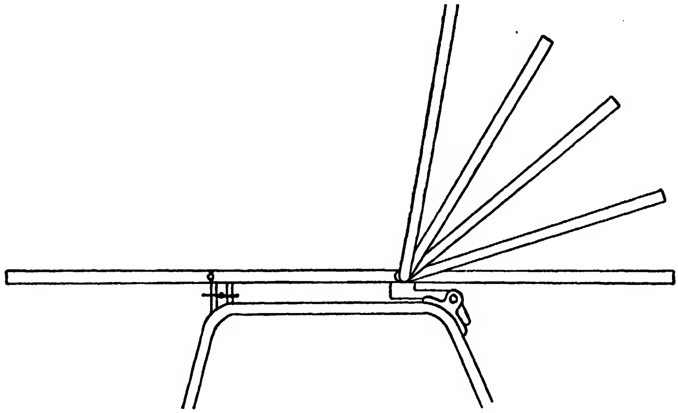


FIG. 128.—DIFFERENT POSITIONS IN WHICH THE PATIENT CAN BE PLACED IN EXAMINING THE ABDOMINAL ORGANS, ESPECIALLY IN KIDNEY CASES, BY RAISING AND LOWERING THE SHOULDER PIECE OF THE TABLE.

grasped when the shoulder part is elevated, the fingers might be crushed in case that part of the table were to slip from the cog in which it is caught.

Over the examining table is placed a large tray table on an adjustable stand, which is exceedingly convenient for holding close at hand the various instruments used in the examination of the patients while on the table.

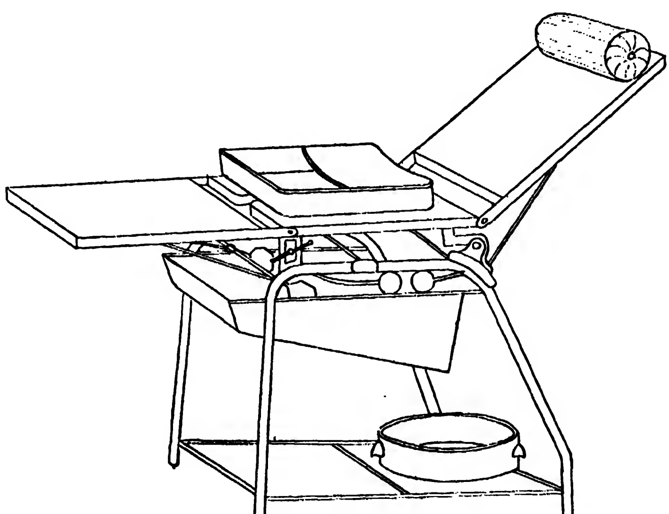


FIG. 129.—COUNTERBALANCE TABLE WITH A DOUCHE-PAN ON IT.

This counterbalance table is probably the best antiseptic metal table that has ever been placed on the market. The slit in the seat part, however, does

not prevent the solutions from wetting the patient during urethra and bladder washings, when it is covered by the leather pad, and the glass or metal is too cold for the bare buttocks. I have personally found an ordinary wood table of my own designing more convenient for treatment than these more modern ones and they are more pleasing to the patient. I have consequently gone back to first principles, in that I do not depend on the slit in the modern tables for draining away solutions during medication, but prefer to place a douche pan under the patient's buttocks, finding that in this way the buttocks and clothing are kept dry (Fig. 129).

In the instrument closet are kept all the instruments and supplies necessary for a thorough examination and treatment of a patient in the office and outside, as well as for an operation. On the top of the closet is a row of glass jars for dressings. Behind the screen, near the washstand, the commode is placed, for the use of the female patients when they void urine for specimens.

Room No. 3 is the next room and has communicating doors with Room No. 2 as well as with the corridor. In the little passage between Rooms No. 2 and No. 3, on shelves, are bottles containing sterile water and solutions, also irrigators and other appliances kept in reserve.

Room No. 3, also finished in white entirely, with an impermeable floor, contains a counterbalance table of the same pattern as that in No. 1. It is also surmounted by an instrument tray with a stand (adjustable). One or more irrigators are hoisted on pulleys over the table from the ceiling, in a manner described farther on. A glass table in this room serves for dressings and solutions, while in the corner is an instrument closet. On the top of this closet is the massage vibrator, properly connected with the electric current; the flexible shaft of this instrument is sufficiently long to reach the treatment table.

In a recess of this room is an electric outfit for high-frequency current, for X-ray work and for cautery and for other electrical appliances. A closet over the washstand holds the stock for the solutions and medicines that are used in the daily work in the treatment of cases. The scales, on which patients are weighed from time to time, are also included in the furnishings of this room.

Besides the examining table and tray stand for the instruments, there is another glass-top table for the apparatus and instruments used in the examination and treatment of patients. This stands just beside the examining table.

Room No. 4, the next in order, is of the same size as No. 3 and communicates with the latter as well as with the corridor. It connects also with the room behind it by means of folding doors. It serves as the second examining and cystoscopic room and is used principally for treating women and for urethroscopy, cystoscopy and ureteral catheterization in both sexes. The general arrangement is the same as Room No. 2, in that it contains an instrument cabinet, washstand, examination and instrument tables. The table for examining and treating patients is known as the Allison (Fig. 130), which I find unequaled

for cystoscopic work. It seems to afford a better position for this purpose than any other, as the seat part of it is shorter than that of other tables. The illustration shows the position of the hips when this table is used in cystoscopic work.

Each of the examining tables is provided with a detachable and adjustable pair of *leg and knee rests*, as seen in the illustrations. The choice of these is a matter of individual preference, the knee rests having the advantage that the patient can be more quickly placed in position than with the straps attached to the leg holders.

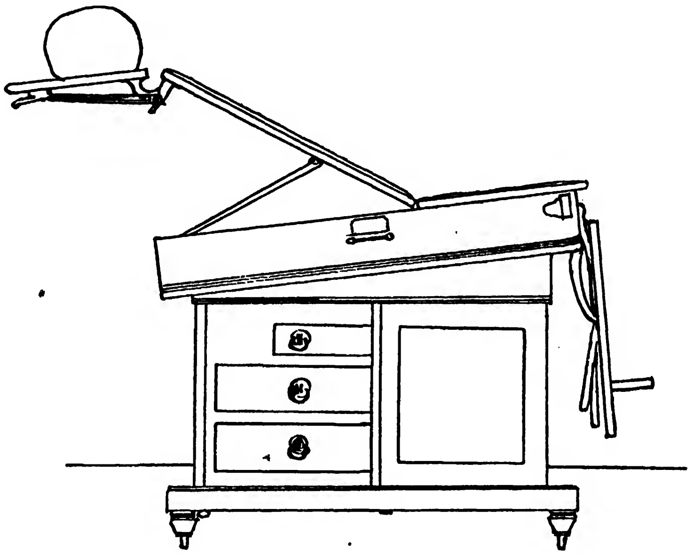


Fig. 130.—Allison Table in the Cystoscopic Position, with Shoulder and Buttock Pieces Elevated.

Knee rests or lithotomy uprights are used when cystoscopy is performed.

In the corner of Room No. 4 is a washstand over which is a closet for solutions, etc., the entire corner being screened by a white, washable curtain swinging upon a hinged rod. An instrument case with glass shelves contains all the instruments used in this room. A glass table with a shelf underneath contains all the necessary articles for conducting cystoscopy and other examinations the same as in Room No. 2.

The next room, *No. 5*, separated from No. 4 by folding doors, is known as the back office, and is the assistant's room, in which correspondence is looked out for and office work attended to which is not accomplished in the main office. The files for histories and records are kept in this room. Doctors who call with their patients often wait here. It is used as a second consultation room in which to take histories and interview patients when the front office is in use. A part of the library is here and easy chairs, and a couch for patients who may want to rest. It forms with Room No. 4 a second consultation and treatment room corresponding to Rooms Nos. 1 and 2.

The last room of the series is the laboratory, *No. 6.* In this room the urines are examined. All the equipment needed for the examination is found here. The room contains washstand, draining boards, closets for chemicals and reagents, the microscopes and laboratory accessories. A desk serves for keeping the records and filing the laboratory cards. Some of the interesting operation specimens are also kept here.

APPOINTMENT NO.................

NAME ....

ADDRESS ....

DIAGNOSIS ....

.... FEE ....

SENT BY..

WILL COME ON..

AT

APPOINTMENT WITH

DR. RAMON GUITERAS

80 MADISON AVE.

NEW YORK

M..

DATE ....

HOUR.......................A. M.,

NO. ....

N. B. Office visits are not expected to last more than a quarter of an hour

No special appointments are given in the afternoon. Patients are seen in the order in which they arrive.

TELEPHONE MADISON SQUARE, 5798. OFFICE HOURS: 9-12 A. M.

FIG. 131.—APPOINTMENT FORM.

Office Management.—A patient, calling for the first time, on entering the reception room is handed a card bearing the date of his or her visit and is instructed to write the name and address. All old patients write their names on a similar card at each visit. Whenever a patient arrives, the attendant at the door telephones upstairs announcing the arrival, which is immediately regis-

tered by the nurse in attendance on the office floor on a list that I have always before me. The card which has been received in the reception room is then brought up and placed on a table in the hall. New patients are shown up to the consultation room and their histories are taken by one of the assistants, who also makes arrangements regarding the fees. The patient is then brought to me for examination, and any specimens requiring examination are sent to the laboratory. When the examination is finished, the diagnosis made, the treatment outlined and an opinion given, if the patient is in need of further treatment in the office, an appointment is given for the next visit. (See Fig. 131.)

The old patients, on arriving, are called up and assigned to one of the assistants with whom treatment is continued until they are discharged. All patients are seen by me personally at each visit or as often as necessary. At the expiration of office hours, the cards of new patients are placed in the file index of patients. A card with the name of the physician recommending the case is put in another file, and cards with the name of the disease written on them are placed in the third file. The history is put in an envelope and placed in a large vertical file. This gives a very thorough record of the case. Very often histories used to lie about in the office pending the wr.. of the urine analysis or other data and consequently no diagnosis of the case was written, no treatment outlined and no diet prescribed. The following rules were therefore formulated and posted over the microscope tables in the laboratory.

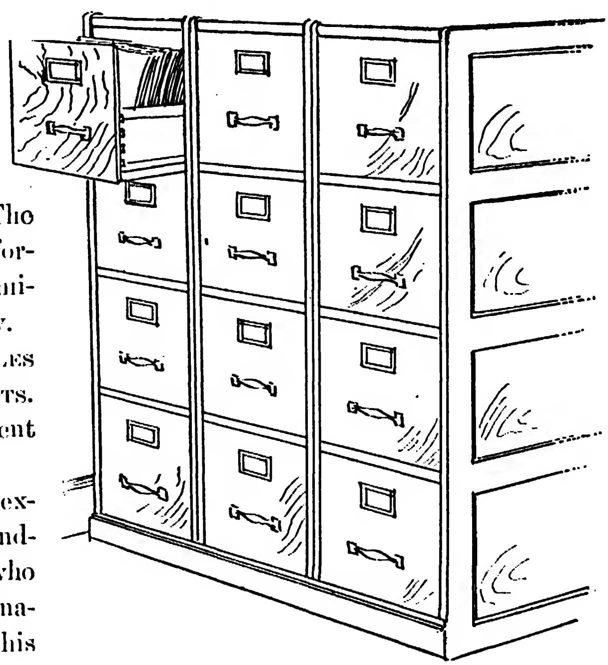


Fig. 132.—Three Vertical Files in Which the Envelopes Containing the Patients' Histories and Correspondence are Kept.

Arrangement of the Rules for the History of Patients.—(1) The history of each patient should be taken by an assistant.

(2) The patient should be examined physically and the findings written down. The one who makes any part of the examination should write it down with his initial after it.

(3) The urine goes to the laboratory and is examined by the laboratory man who writes the urine report on the examination card. It is then sent to me for the diagnosis and should not be filed until the diagnosis is written upon it.

If there is an opinion to be given, it should be written out by me and under no circumstances should the history be filed without this having been done.

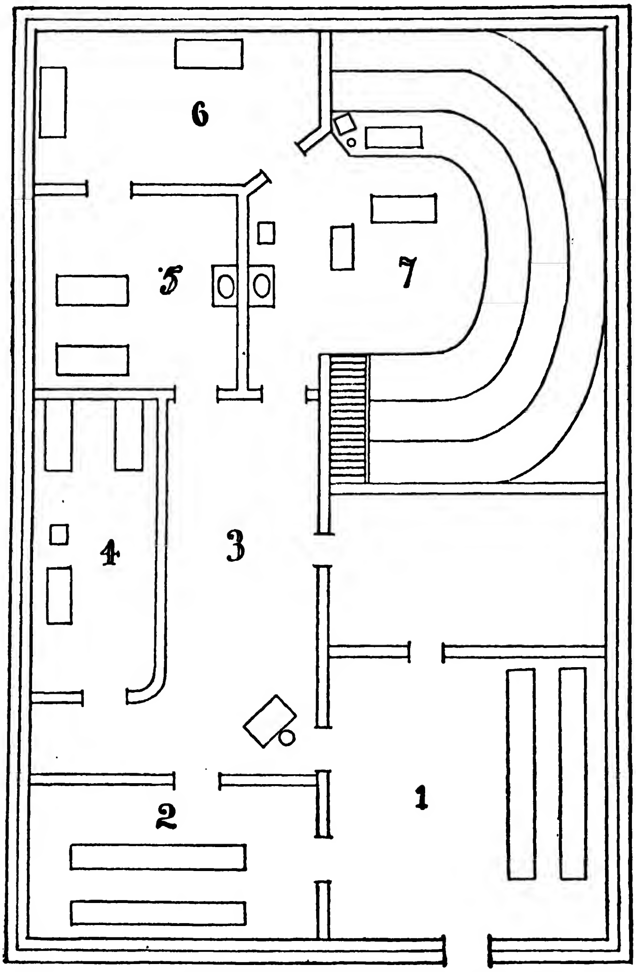


FIG. 133.—PLAN OF THE CLINIC AT THE NEW YORK POST-GRADUATE MEDICAL SCHOOL.

1, waiting room for old patients.
2, waiting room for new patients.
3, passage to Rooms 4, 5, 6, and 7.

In the corner of Room 3 is seen a table and chair where the history file is kept by the historian. The room to the left of Room 4 is for the acute cases. Room 5 is the room for chronic cases. Room 6 is the cystoscopic room. Room 7 is the amphitheater. Each of these rooms has two treatment tables, an instrument table and a sterilizer.

When these letters of opinion and diet are written, a carbon copy should be made and they should be submitted to me before they are sent out.

All correspondence is kept in the history envelope.

The management of the office is entirely in the hands of the nurse who is also secretary. She has care of the correspondence, the appointments for visits and operation, the patients' accounts, the laundry, the purchase of office supplies, the making of the dressings, the sterilizing of the instruments and dressings and the lists of instruments and apparatus that leave the office for outside operations.

Equipment for Clinic and Hospital.—The work in the clinic corresponds to that in the office on a large scale, although the equipment and records are not kept so carefully. There are generally plenty of assistants, most of whom are there to learn the routine of the work of the clinic and who are generally not so well trained as are office assistants.

The clinic records are, therefore, but about a quarter as valuable, except

so far as a record for the number treated is concerned. The greatest difficulty is found in obtaining assistants with the true scientific spirit who are willing to give their time to tabulating statistics, to investigating new methods and to doing research work outside of the clinic.

The plan of the clinic (Fig. 133) is that of a semicircle and is arranged as follows:

No. 1 is the general waiting room. No. 2 is the waiting room for new patients. No. 3 is the passage in which the records are kept. No. 4 is the first-treatment room. No. 5 is the second-treatment room. No. 6 is the cystoscopic room and No. 7 is the amphitheater or lecture room. The old patients enter in the basement Room 1—the new ones are brought into Room 2 where they wait for the lecture.

Room 3 is the passage and here is the table at which the card index is kept. The clinic filer, who sits at this point, directs the new patients to enter from Room 2 for the lectures and the old patients come in from Room 1 to be treated in the other rooms. The card filer hands the cards to the patients as they come in and replaces them when they pass out. The first assistant investigates the new patients before they go to the lecture room, writing down their names and principal symptoms, and brings the list into the lecture room (No. 7). The lecturer reads over the list and has the cases sent in as chosen. The patient, on entering, is placed on the table, his history is taken aloud by the lecturer, and recorded by the historian. The local examination is then made by inspection and palpation.

If the patient is an acute case, there is usually but little difficulty in making a diagnosis. If the case is chronic, however, the patient is instructed to leave the table and pass his urine in two glasses. The first and second specimens are inspected and the appearance noted, after which the patient leans over the table and the prostate gland and seminal vesicles are examined. The patient then passes the remainder of his urine, containing any débris that has been expressed from the internal genitals during examination. The three specimens are then handed to the microscopist, seated at the table, for examination. While he is attending to this, the patient is again placed on the table and the lecturer proceeds to examine the urethra with the instruments at hand. As the instruments are used, they are handed to an assistant, who attends to the sterilization.

After the patients have been examined and the diagnoses made, they are each referred to a certain clinical assistant outside, whose patients they then become and who are treated by him until cured, unless some complication occurs or the assistant in charge of the case desires him to come again before the lecturer. All the acute cases are sent to the first-treatment room (No. 4) and are placed in the care of the two assistants in charge of this room. All chronic cases are sent to the second-treatment room (No. 5), in which there are also two assistants working. When an acute case becomes chronic, the physician in

charge can either continue treating him or else refer him to the room for the chronic cases. In both these rooms, there are two treatment tables, an instrument and a sterilizing table and some chairs. The instruments are of the same variety as those used in the office.

Room 6 is the cystoscopic and bladder room. In this are two tables, on one of which the patients are prepared for cystoscopy, while on the other they are examined by the cystoscopist. As the preparation for cystoscopy takes some time, the case lectured on is not prepared in the amphitheater, but outside, after which the patient is wheeled into the lecture room with the cystoscope in the bladder, ready for examination. This is the usual routine, but in cases in which the fluid medium becomes rapidly turbid, as in marked pyuria and hematuria, the last washing is given in the lecture room and the cystoscope is then introduced.

The clinic is managed by a chief of clinic, who goes about from room to room and gives help and advice to the clinical assistants. Clinic patients are in charge of the first assistant. One man is at the head of the cystoscopic room, and two in each of the treatment rooms, the man who has had the longest duty outranking the other in each of the rooms. The records are in charge of two men, one in the lecture room who takes all the histories, the other on the outside who makes notes, at each lecture, of the interesting cases that are kept under observation, such as the kidney, bladder and stricture cases, as well as those who are to be operated or have already been operated upon.

The new men coming to assist the clinic go through a regular circle of services before they are permanently appointed clinical assistants, serving in each for at least three months. The rotation is as follows: Historian in the amphitheater; first-treatment room, treating the acute cases; second-treatment room, treating the chronic cases; third-treatment room, working in cystoscopy. When they have finished cystoscopy, if fitted for it, they go on the microscope, otherwise they go on the book and around the circle again, as the head man of the different departments.

The development of the clinic and of the clinical assistant has been very satisfactory of late, owing principally to the formation of an Alumni Society, that meets once a month, at each of which meetings one of the assistants reads a thesis on some subject that has been assigned as a special work.

The *hospital* is connected with the clinic, inasmuch as the patients requiring operation are referred to the hospital for the operation clinic, which takes place once a week. After they recover, they are again sent to the clinic for observation and treatment. Patients are also referred to the hospital for treatment, although it is principally for an operative service. The same instruments and apparatus are used at the hospital and for outside work, as have already been indicated under Equipment for the Office.

CHAPTER VII

STERILIZATION OF INSTRUMENTS AND APPARATUS

The methods of destroying germs applicable to urological instruments are: Disinfection by means of chemicals, by boiling, by steam, and by the vapors of bactericidal substances. It is important to know the particular method which is suitable for each special class of instruments, as some appliances are injured by subjecting them to the wrong process. Probably the most efficient method of disinfecting an instrument that can be sterilized by any method is by boiling or steam. The least effective of the methods at our disposal is disinfection in chemical solutions, a method which is used chiefly in emergencies. Disinfection with chemical vapors is more thorough and more trustworthy than with solutions, and the vapors of formalin have now been adopted very generally in the disinfection of urological instruments which do not bear the application of heat.

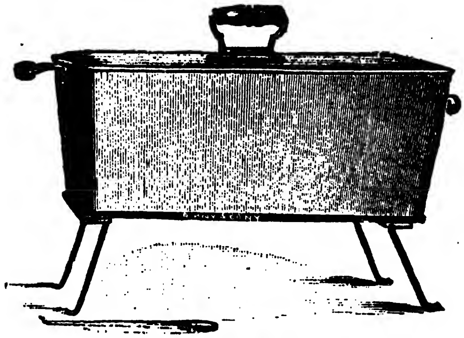
Chemical Solutions.—Formerly it was considered sufficient, for all practical purposes, to disinfect certain urological instruments, such as catheters, by immersing them in solutions of carbolic acid or bichlorid of mercury. It has been shown, however, that these methods are untrustworthy, and that even when catheters are immersed for half an hour in a 1:1,000 solution of bichlorid, living microörganisms have been found within their lumen.

Of the solutions which are employed with more or less safety in the sterilizations of urological instruments, we may mention formalin and mercuric oxycyanid, the latter 1:1,000 to 1:500. Formalin is probably the better of the two, and can be used in a strength of from two to five per cent. The most convenient solution of formalin is that recommended by Holtzein, which serves for the disinfection of cystoscopes, urethroscopes, woven catheters, etc. The stock solution consists of sixty parts of formalin and forty parts of alcohol. Two drachms of this solution are added to each pint of distilled water for immediate use.

Mercuric oxycyanid is employed in the strength of 1:200 for the disinfection of delicate instruments, such as cystoscopes, etc. The value of this substance is rather questionable.

Boiling.—Boiling is one of the best ways of attaining absolute asepsis. The material to be boiled, however, must be carefully selected. Metallic instruments, consisting entirely of metal or of glass or the two combined, may be

boiled with impunity. It is always best to add some soda to the water, so as to prevent rusting and to preserve the nickel plating. Soft-rubber catheters may also be boiled, but plain water should be used. The time required for boiling any of these classes of instruments is five minutes. Any instrument boiler, fish boiler, or common agate or enameled pan, can be used. Special long and narrow pans with covers are useful for boiling soft rubber, glass or metal instruments in the office or the treatment room.



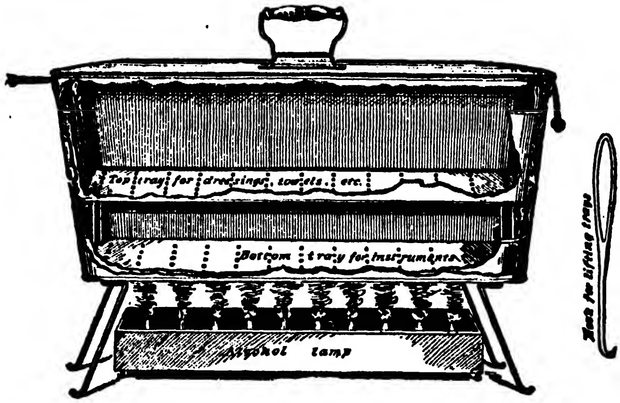


Fig. 134.—Willy Meyer Sterilizer for the Sterilization of Dressings and Instruments.

Steam.—When employed correctly, steam under pressure disinfects with the same efficiency as boiling. The steam must penetrate through every part of the material to be disinfected, and the time of exposure must be sufficient to kill the most resistant germ; that is, about twenty-five minutes. Disinfection with steam requires special apparatus, although in an emergency an ordinary fish kettle, with a perforated pan hanging over the boiling water, can be employed. One of the best all-round steam sterilizers is that known as the "Willy Meyer" (Fig. 134). This can be used for both dressings and instruments, and is very convenient for carrying to an operation at the patient's house. Another of about the same size, though a more complicated sterilizer, is the type known as "Rochester Combination" (Fig. 135). In this sterilizer, we can use alternately steam and dry heat, so that the steamed articles can be dried by heat without removing them from the trays. Both these sterilizers have an arrangement for boiling instruments in the water which produces the steam.

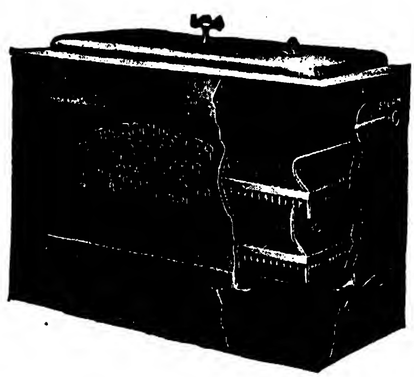


Fig. 135.—Rochester Sterilizer.

Formalin Vapors.—Formalin vapors offer a very convenient, and at the same time very efficient, way of disinfecting all kinds of urological instruments, especially cystoscopes, woven catheters, etc. The most convenient apparatus for this purpose is Schering-Glatz's formaldehyd sterilizer (Fig. 136).

This apparatus consists of a box of japanned tin, measuring 18 x 11½ x 8 inches. It has two shelves upon which the instruments may be placed, and a small compartment for the formaldehyd lamp. One side of this box swings on hinges, forming a door of sufficient size for the introduction of the longest

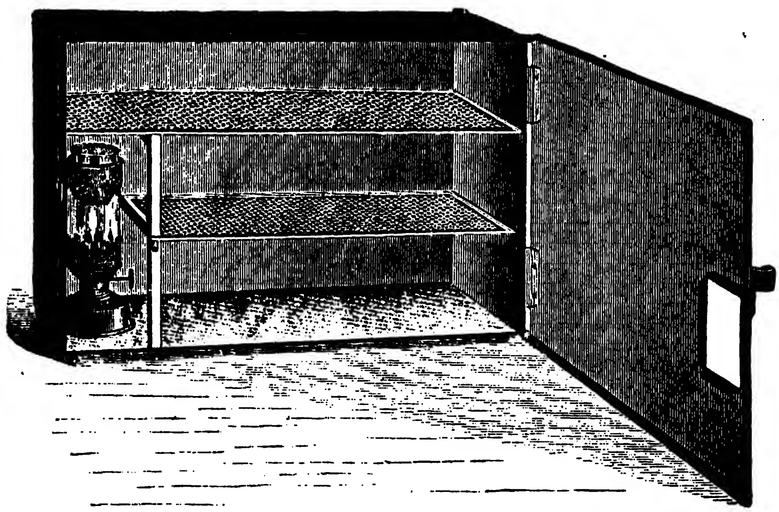


Fig. 136.—Formalin Sterilizer, Used Principally for Woven Catheters, Piston Syringes and Cystoscopes.

instruments that the box will hold. The lamp is about eight inches high, consisting of a body for the alcohol and a chimney, in the top of which is a cup or receptacle for formalin pastilles, white tablets which by heat are completely converted into formaldehyd gas. The strength of each pastille is five grains. Two of these tablets are sufficient for ordinary disinfection in this apparatus.

The instruments are placed on the wire shelves. Two five-grain paraform pastilles are put into the cup or receptacle. The lamp is now lit and the door closed. A small glass window in the door permits us to watch the flame of the lamp. An outlet at the top of the box allows the escape of gas when sterilization is complete. The lamp will burn for twenty minutes in the air of the box, when empty. About ten minutes are needed to burn a five-grain pastille of paraform in the sterilizer. Ten minutes' exposure to the amount of gas obtained by vaporizing two five-grain pastilles will kill anthrax, diphtheria, tubercle and typhoid germs, as well as those of suppuration. At my suggestion, Prof. H. T. Brooks, of the Post-Graduate Hospital, made a series of experiments with this

sterilizer to determine its efficiency. The following is an extract from his report, which was sent to me in December 17, 1899.

Woven catheters were injected with dilutions of live cultures of the typhoid, colon and prodigiosus bacilli, and the Staphylococcus aureus. The catheters were then drained, dried, and placed in the Schering formalin sterilizer. Two pastilles were burned for ten minutes, after which the lamp flame was spontaneously extinguished. The door of the sterilizer was then opened, two new pastilles placed in the cup above the lamp chimney, the lamp relighted, and the door closed. The lamp was then allowed to burn for an additional ten minutes. The door was not opened until a third ten minutes had elapsed—i. e., thirty minutes from the beginning of the exposure. The catheters were then removed from the chamber with sterile forceps, cut with sterilized scissors, and portions placed on gelatin plates, in tubes of alkaline bouillon, and also in surface and submerged agar tube cultures. No growth of any of the above-mentioned organisms occurred after three days in the incubator at 98° F. Control cultures were made from the original dilutions used for injecting the catheters, and all grew.

Subsequent experiments showed that the tubercle bacillus and the streptococcus also were killed by exposure to the formalin fumes for half an hour.

Detailed Methods of Sterilization and Disinfection:

1. Water.
2. Surgeon's hands.
3. Rubber gloves.
4. Packages of dressings and tubes of gauze.
5. General care of instruments.
6. Catheters.
7. Cystoscopes, urethroscopes, etc.
8. Piston syringes.
9. Glass hand syringes.
10. Instillation syringes.
11. Hypodermic syringes and needles.
12. Glass and agate ware, etc.; infusion jars; irrigator jars and tips; pans, pus basins, pitchers, dishes, trays and glass jars.
13. Catheter lubricants.

Snell's formaldehyd sterilizer is recommended for catheters (Fig. 137).

1. Water.—The quality of the water used in the office for making our solutions was found unsatisfactory. It was ordinary boiled city water and at times was discolored and often formed some chemical combination with silver or other salts used for solutions. Besides this, the enamel was burned off the bottom of the kettle, giving rise to a certain amount of mineral deposit in the water. When this occurred in the instrument sterilizer, which was of the same

construction as the kettle, a gritty substance clung to the instruments, while a scum floated on the water. For a long time we used filtered water, which had been boiled, but even filtered water formed a chemical combination or gave rise to precipitates. We then began to use distilled water, which has proved most satisfactory.

In the smaller towns, this can be made in the office with the aid of a still, such as are now used for its rapid manufacture. In the large cities we simply buy distilled water in five-gallon bottles. The water is heated in a large tea kettle, which should be changed for another as soon as it is burned in the least degree.

After the distilled water has been heated, it is poured into an aseptic pitcher and thence into an earthenware jar with a faucet in the lower part. The

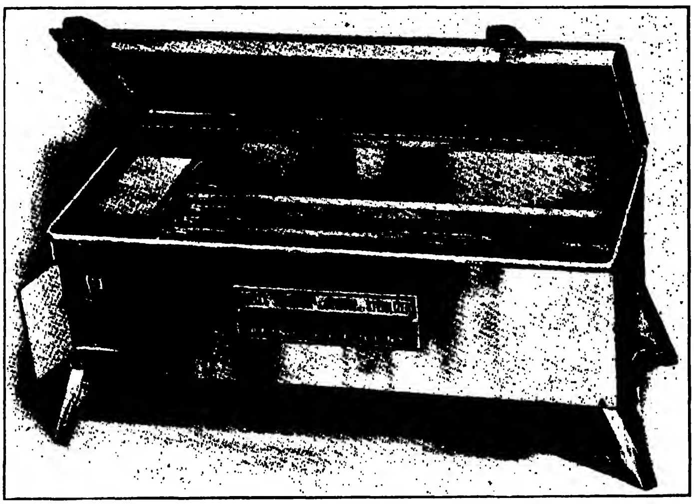


FIG. 137.—SNELL'S FORMALIN STERILIZER FOR STERILIZING ALL CATHETERS, BUT ESPECIALLY URETERAL.

The catheters are pushed over hollow posts leading to the formalin chamber.

sterilized water is drawn, as needed, from this jar. The kettle is always kept full of hot water in order to replenish the treatment-room jar whenever necessary. The cooled water is drawn off into a second jar, which is kept beside the one for hot water in order to mix the two for solutions at a proper temperature. An extra supply of cold sterilized water is kept in sterile flasks, stoppered with cotton or gauze.

2. SURGEON'S HANDS.—The care of the hands is one of the most important details in a urological office. It is a problem how to keep the hands clean, as they are constantly touching septic matter. Each treatment room should be provided with soap, brushes, nail cleaners and jars of bichlorid for the hands.

3. RUBBER GLOVES.—At intervals I have worn rubber gloves, but have never become accustomed to them in office work. There is so much changing

of clothes, telephoning, handshaking, prescription writing and other matters of a business and social nature transacted during office hours, that the changing of gloves becomes a difficulty and involves a great loss of time. The surgeon should, however, wear rubber gloves in the treatment of all cases which threaten infection. In the office, they are washed with soap and water, wrapped in a towel, and boiled for ten minutes after using them, then dried, powdered and wrapped in gauze and put away until next needed.

4. Packages of towels, gauze compresses, sponges or pads, gauze bandages, cotton balls, sanitary pads, muslin table covers and sheets should be sterilized by steam. Strips of plain gauze, for packing, should be sterilized in the tubes in which they are kept.

5. General Care of the Instruments After Using.—After use, all instruments should be washed in hot water and green soap with a soft brush or piece of gauze, thoroughly dried and put away. Special care should be taken, in the case of cystoscopes, not to submerge the entire instrument in cleaning or other solutions. Metal instruments should be cleaned in the same manner as house silver, when they begin to tarnish. All instruments should be kept free from dust in closed cabinets, or between towels if on open shelves.

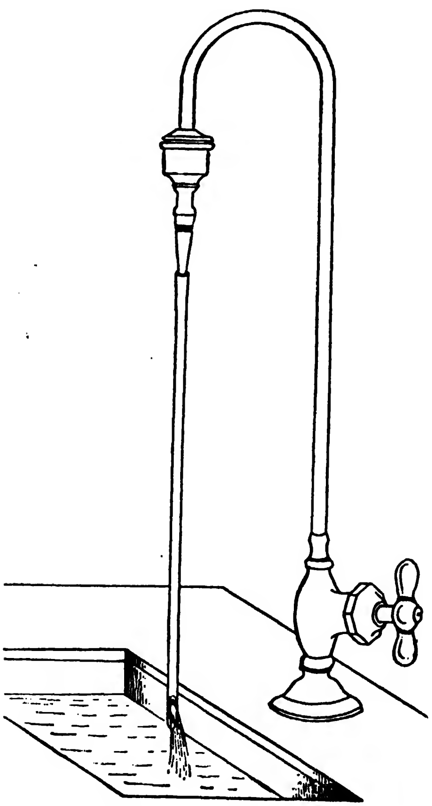


Fig. 138.—Method of Flushing out Catheters Employed in Author's Office.

6. Catheters.—It is very difficult to clean catheters and other hollow instruments, as the remnants of pus, mucus and blood are apt to remain adherent to their interior. This is especially true when greasy lubricants have been used. A catheter must be flushed out, after using it, with soapsuds, by means of a piston syringe, or by attaching to a sink faucet a small nozzle which will fit into the lumen of the catheter. In this way, a strong jet of water can be made to flow through it (Fig. 138). This is most important especially in woven catheters, which are usually sterilized by means of gas or chemical solutions that do not penetrate a coat of dried albuminous matter containing infection that adheres to their inner walls.

Soft-rubber catheters are best sterilized by boiling for ten minutes in

plain water after a thorough cleansing. They should be wrapped in gauze or a towel and put into the boiler so that they do not come in contact with the wall of the boiler and become burned. In the office, we boil our catheters in bags

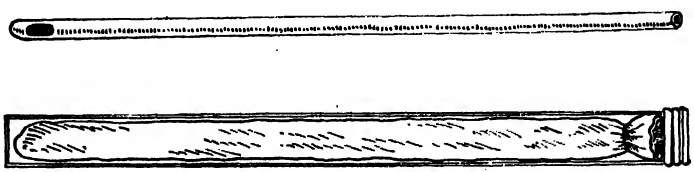


FIG. 139.—CATHETER AND CATHETER TUBE.

and then put the bags into glass tubes. In this way they are handled more easily than in the wet bags alone (Fig. 139).

Woven urethral and ureteral catheters cannot be boiled or placed in carbolic acid. They may be sterilized either by immersing them for thirty minutes in a solution of silver nitrate or of mercuric oxycyanid (1 : 1,000), or else by exposing them to the vapors of formaldehyd in the formalin sterilizer. The last-named method is the best and is the one used in the office.

Another way of sterilizing woven catheters by formaldehyd, consists in placing them in a glass tube, in the stopper of which is a rubber receptacle containing formalin tablets (Fig. 140). The lower part of the stopper is perforated and through these perforations the vapors of formalin are constantly passing into the tube. They can also be placed in boxes in the center of which is a piece of gauze containing tablets or a powder of formalin. The formaldehyd gas is spontaneously generated and sterilizes the catheters in twenty-four hours. Special boxes are constructed for this purpose, although any ordinary flat air-tight tin box will do as well.

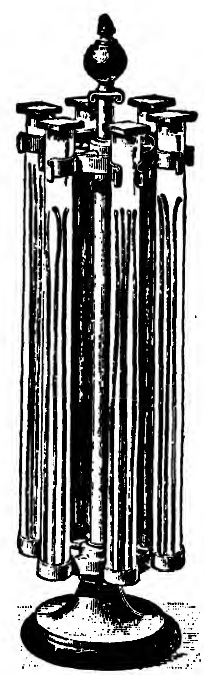


FIG. 140.—TUBES WITH HOLLOW RUBBER STOPPERS CONTAINING FORMALIN.

7. CYSTOSCOPES, URETHROSCOPES and other delicate instruments of this type are sterilized in the formalin sterilizer. After being used, the outer surface of the shaft is washed with tincture of green soap and water by means of a piece of gauze, then with alcohol, after which they are laid away in their cases, or, better still, wrapped in gauze, ready to be sterilized at any moment.

8. PISTON SYRINGES of large size, that is, holding from four to six ounces,

such as are used for washing out the bladder, are usually made of hard rubber, metal or glass and metal. They are best sterilized with formalin gas in the Schering sterilizer. The metal syringes and those of glass and metal can also be boiled. They may be sterilized in chemical solutions the same way as the woven catheters, but they are better sterilized in the chemical vapor (formalin).

9. Glass hand syringes are usually kept in jars with cotton in the bottom, partly filled with five-per-cent carbolic or a 1 : 500 bichlorid solution and placed nozzle down. I keep mine in alcohol and rinse them with sterile water, as then no deposits form on the instruments that will make chemical combinations with the salts in the solutions used. Another good way is to keep them in water and boil before using them.

10. Instillation Syringes, Aspirators, etc.—These are sterilized in the same way as the large piston syringes. The instillation metallic catheters are boiled before being used.

11. Hypodermic Syringes and Needles.—Hypodermic needles should be boiled before using. The needles are kept in a small glass box containing a powder made of equal parts of boric acid and lycopodium, always with their wires passed through their lumen. Two small glasses, one for a five-per-cent carbolic solution, the other for sterile water, are kept on a tray on a shelf, called the emergency shelf, during the office hours; also one-ounce bottles of atropin solution (10 drops equal to $\frac{1}{150}$ of a grain); of camphor in oil (10 drops equal to 2 grains); of strychnin sulphate (10 drops equal to $\frac{1}{30}$ of a grain); and pearls of amyl nitrate, each containing 3 grains, in a cotton-lined box. These should also be kept at hand on a table in hospitals and outside operations in case of emergency. A little glass receptacle with a cover contains cotton balls in ninety-five-per-cent alcohol.

For local anesthesia, special solutions, which are prescribed in the appropriate chapter, are kept on a tray with special syringes and needles, arranged in a similar manner to the hypodermic tray just described. (See chapter on Anesthesia.)

12. Miscellaneous Articles of Hard Rubber, Glass, Porcelain and Agate Ware.—Irrigator tips and couplings of glass or hard rubber, to be used with rubber tubes and catheters, are kept in glass jars containing bichlorid solution.

Irrigator jars should be washed out daily and flushed out with 1 : 1,000 bichlorid solution.

Infusion jars are an important part of the operative outfit and should hold two quarts; a thermometer is provided for each. They are kept filled with bichlorid solution and are cleansed with sterile water before using. The tubes, cannulas, etc., are kept wrapped in a towel, sterile and ready for instant

use. Two bottles of sterile salt solution, one drachm to the pint, are kept at hand for use with this apparatus.

Pans, pitchers, pus pans, dishes, basins, trays and glass jars should be divided into classes, those for aseptic cases and those for septic. Pitchers, basins for solutions or sterile water, instrument pans, trays, glasses for solutions, etc., should be thoroughly washed and cleaned with soap and water, rinsed out and put into a tank, or an unpainted washtub, where they are kept submerged in 1:500 bichlorid solution. If they are not to be used immediately, they are kept bottom up on glass shelves or wrapped in sterile towels. Glass jars in which dressings are kept are cleaned in the same way and should be kept in the bichlorid solution, with their covers on, for an hour, and then dried with a sterile towel.

Pans for the reception of dressings which have been removed, pus pans or basins, urine tubes and all other soiled articles of this order should be scrubbed with soap and water, rinsed with bichlorid and kept in their customary places without further attention.

13. Lubricants for Instruments.—The lubricants generally employed for urinary instruments include petroleum bases (vaselin), oils, glycerin and vegetable bases. Vaselin should never be used, except for rectal examinations. Olive oil should be used only after sterilizing it thoroughly by allowing the uncorked bottle to stand in boiling water until the oil itself boils. The only cases in which olive oil is useful is in examination for a supposedly impassable stricture. Certain oils are prepared with an antiseptic, as gommenol, which is a preparation of olive oil and eucalyptol.

The usual lubricant employed in both hospital and office work is glycerin. This is kept in tall jars, into which sterilized instruments can be easily dipped. Glycerin is easily kept sterile, as germs do not thrive in it. Some surgeons use boro-glycerid, which is a compound of boric acid and glycerin, containing thirty per cent of the former. Personally, I do not care for it, as it sometimes irritates.

The vegetable bases, which have of late years been employed for lubricants, are composed chiefly of tragacanth, or of Irish moss (chondrus, carragheen). These bases have the advantage of being soluble in water and sufficiently slippery to be an efficient lubricant.

They are easily washed off from the instruments or washed out of the canal. Most of the lubricants now on the market contain such a base, and have added to them either boric acid, eucalyptol, thymol, formalin, etc., as antiseptics. They are usually put up in collapsible tubes with a nipple-shaped nozzle which can be used to introduce the lubricant into the urethra before passing sounds. The nozzle can be sterilized by boiling, or each patient should have his own tube of lubricant. The lubricant that I use in the office is made according to the following formula:

℞ Tragacanth .... ʒss;
Glycerin .... ʒvijss;
Hydrarg. Oxycyanid .... grs. ij;
Aquæ .... ℥iij.

The objection to oil and vaselin in urethral work is that they leave a coating over the mucous membrane of the urethra and thus prevent the thorough medication of the canal afterwards.

CHAPTER VIII

TECHNIQUE OF INSTRUMENTATION

CATHETERS

A CATHETER is a hollow tube with an opening at one end the size of its lumen, while at the other end the opening is smaller and called the " eye." This is either in the tip or near it.

Shape of Catheters.—The shape of the catheter is either straight (Fig. 141), or elbowed (Fig. 142) or curved (Fig. 143). The *straight* has the same caliber throughout, or else it tapers into the neck and then widens out at the end forming a small olive-shaped dilatation (olivary tip) (Fig. 144).

FIG. 141.—STRAIGHT CATHETER WITH SINGLE EYE, USUALLY OF THE SOFT-RUBBER VARIETY.

FIG. 142.—ELBOWED, COUDÉ OR MERCIER CATHETER WITH THE EYE ON THE SIDE, USUALLY OF THE WOVEN VARIETY.

FIG. 143.—CURVED CATHETER OF THE WOVEN VARIETY. Not much used.

The neck is the narrowest part of the instrument, while the olive-shaped end, though larger than the neck, is smaller than the shaft.

Elbowed catheters have a curved beak, somewhat similar to that of a sound, but shorter and more angular. They are also called coudé or Mercier catheters. When the beak has a double curve, it is called bi-coudé (Fig. 145). Curved catheters are shaped like sounds.

FIG. 144.—STRAIGHT OLIVE-TIPPED WOVEN CATHETER.

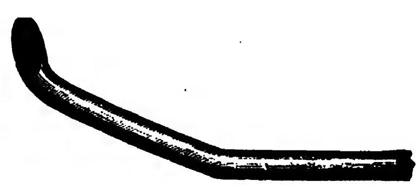


FIG. 145.—BI-COUDÉ WOVEN CATHETER.

Catheters are made of soft rubber, of a woven material with a varnish finish, or of metal. Those made of other material are not recommended.

The Eye of the Catheter.—The eye of the catheter is the opening through which the water escapes into the urethra or bladder. It is more frequently on the side, the end opening be-confined principally to instillating and large perineal drainage catheters.

Openings on the side may be either single or multiple. The single opening is most common, usually oval in shape and, especially in the soft-rubber variety, situated about a quarter of an inch from the tip (Fig. 146). The edges are rounded, so they may not give rise to traumatism of the canal. Such a finish is frequently spoken of as the "velvet eye." Straight catheters, whether they are soft rubber or woven, usually

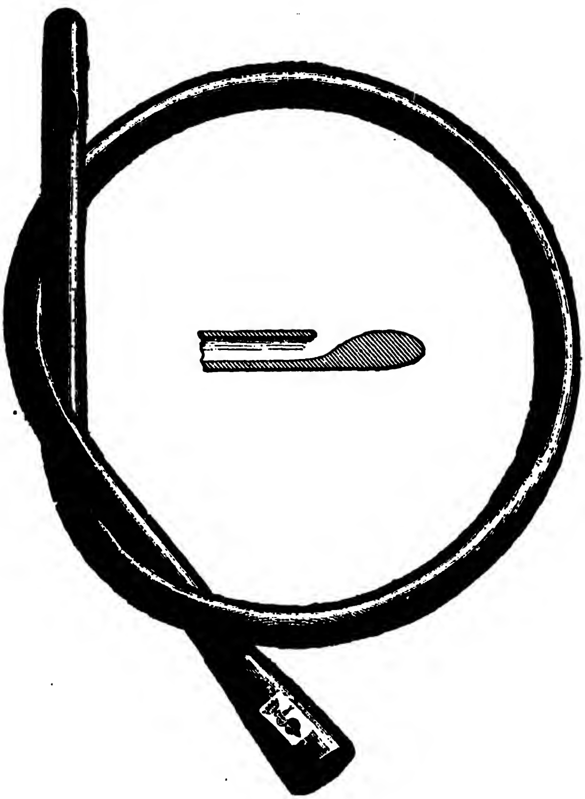


FIG. 146.

FIG. 147.

have but one eye. In the olivary type of woven catheter, the eye is situated in the body of the catheter, and may be one inch or more from the tip.

In the elbowed catheter, when made of soft rubber, the opening is usually made in the concavity of the elbow, although, when the catheter is of a

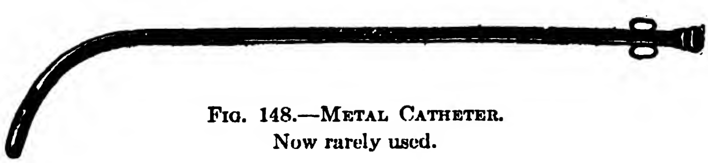


FIG. 148.—METAL CATHETER.
Now rarely used.

large size, it may be on the side, between the convexity and the concavity (Fig. 147). Side openings are generally found in the woven catheters, in which case two or more may be present. In the single-elbow catheter, there

are rarely more than two, one on each side. Metal catheters are also better when they have the openings on the side (Fig. 148).

Catheters for giving a general irrigation of the urethra may have multiple eyes—a dozen or more small round openings, through which the water spurts against the urethral walls (Fig. 149). They are generally of soft rubber in texture. Perineal drainage catheters, to be used after operation, usually have an opening in one end and on the side to allow better irrigation.

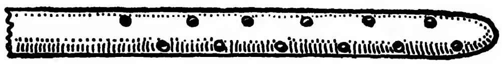


Fig. 149.—Nélaton Catheter.

The Passing of the Catheter.—A soft-rubber catheter is dipped into a lubricant in such a way that about one half of it is covered. It is then held in one hand, with the fingers a few inches from the tip. The meatus is opened by the thumb and forefinger of the other hand, the organ being at right angles to the body. The end of the catheter is then brought into the opening while dangling from the fingers. After the tip has entered the urethral meatus, a few downward impulses are made and the instrument glides down the canal. When the catheter has passed down the canal to the point at which the fingers are holding it, they are moved farther up on the instrument and the downward impulses continued, by means of which it glides through the deeper portion of the canal and into the bladder. When eight and a half inches of the catheter has passed down the urethra, urine will usually escape from its eye. As the catheter passes down the canal, it may catch at the compressor urethræ, or neck of the bladder, this being due to spasm. Such is usually the case when there is inflammation of the prostatic urethra, or of the neck of the bladder. Such a spasm will usually yield to gentle pressure, or it may be overcome by substituting a woven for a soft-rubber catheter, or an olivary-tipped instrument for one with a larger end. A metal catheter will sometimes enter when others will not. Urine will not escape until the catheter has reached the bladder.

Straight catheters are used for washing out the anterior and posterior urethra and bladder, and for drawing urine from the bladder that cannot be passed spontaneously.

Elbowed catheters are also used in bladder work in drawing off urine in retention and washing out the bladder where inflammation is present. They are especially valuable in cases of enlargement or deformity of the prostate gland. The best coudé to use is the soft rubber, but it is usually not as easily passed as the woven variety.

The object of bends, angles or elbows in the ends of the catheters is to allow them to pass over prostatic enlargements, bulging into the urethra. It is easy to understand how the end of a straight catheter would come up against a protrusion in the prostatic urethra and might not pass it, while the elbowed catheter meeting such an obstruction would have its convexity at the end parallel to the

side of the protrusion. Its tip would be against the roof of the prostatic urethra and a slight push would thus send it along the upper wall and past the prostatic enlargement into the bladder.

The *metal catheters* are passed the same as sounds. They are not in common use, but will sometimes pass in cases in which soft-rubber and woven instruments will not. At present I use the metal variety almost entirely in washing out or filling the bladder after a perineal section, as with this instrument I can hug the upper wall of the urethra better, and, consequently, am not so liable to pass the catheter through the incision in the floor of the perineal urethra as might be the case with a straight instrument.

The catheter with a mandrin, a wire in its lumen, such as is used in the urethra to overcome prostatic impediments, is not, in my opinion, a good instrument. In using this instrument, it is passed as far as the obstruction in the prostate and the mandrin is then withdrawn, thus giving a slant to the tip of the catheter, so that it will glide up and forward through the prostatic urethra and enter the bladder. It seems to me that the improved models of elbowed catheters have sufficiently good curves, cause less traumatism and can at present be used in all cases in which the mandrin types were formerly employed.

Retained Catheters.—A retained catheter, or a catheter *à demeure,* is one which, having been passed through the urethra, is fastened in such a way that it will not slip out. Retained catheters are useful whenever it is desirable to establish continuous drainage from the bladder, or to protect the walls of the urethra from contact with urine. Usually this necessity arises when the bladder is infected, when an operation or traumatism has been done in the urethra, when it is necessary to cure a suprapubic vesical fistula, and also when spasms prevent repeated catheterization in cases of a complete retention.

Unless the retained catheter is properly introduced and properly maintained, it may give rise to complications, as an ulceration of the bladder, when the instrument is inserted too far, so that its end presses constantly upon some point of the wall. At other times, there is an ulceration of the upper part of the deep urethra, just beyond the pendulous portion, at which point the catheter is bent when the urethra hangs down, thus compressing the above-mentioned portion of the wall. These accidents are rare in my own practice, as I generally use a soft-rubber catheter, and only employ woven catheters *à demeure* immediately after an operation when there are blood clots in the bladder. I believe that the soft-rubber catheters made in this country are superior in quality to the European product and that, consequently, we do not meet as much trouble with retained catheters as do some of the foreign surgeons.

Catheters may be retained for several days or several weeks. They should be so introduced that the eye and the tip alone are in the bladder. This means that the catheter should be pulled forward after having entered the bladder until the flow just ceases and then pushed back a trifle until the flow is reëstab-

lished. The bladder is emptied and the flow continues in dribbles corresponding to the flow of urine from the ureters.

The next problem is to maintain the catheter in place. My own method is simply to tie two pieces of thread about the instrument close to the meatus,

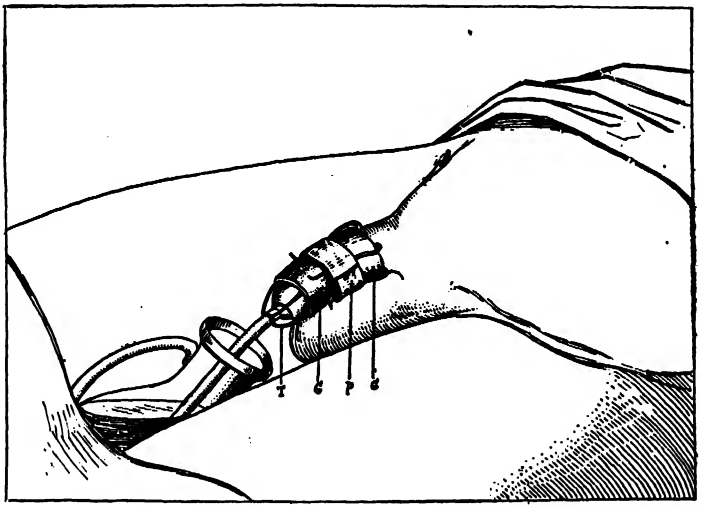


FIG. 150.—RETAINED CATHETER.
P, adhesive plaster. *G*, gauze. *T*, retaining threads.

then to reflect the threads back on the upper, lower and lateral surfaces of the organ and to hold them in position by a piece of gauze or adhesive plaster wrapped around the penis (Fig. 150). The point at which the

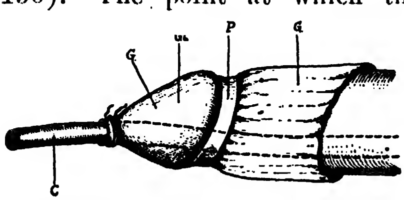


FIG. 150*a*.—A MORE SECURE METHOD OF HOLDING A RETAINED CATHETER.

C, catheter.
G, a piece of gauze surrounding the organ and tied to the instrument.
P, a strip of plaster passed around the gauze-covered organ just behind the corona.
Gl, glans penis.

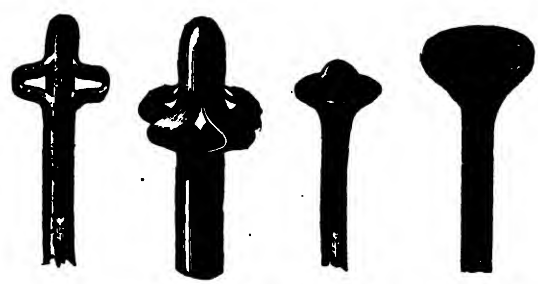


FIG. 151. FIG. 152. FIG. 153. FIG. 154.

FIG. 151.—MALECOT'S CATHETER.
FIG. 152.—ANOTHER TYPE OF MALECOT'S CATHETER.
FIG. 153.—PEZZER'S CATHETER.
FIG. 154.—ANOTHER TYPE OF PEZZER'S CATHETER.

thread should be tied around the catheter is, of course, determined by the maneuver already spoken of, whereby the exact position of the instrument is secured for efficient drainage. The catheter can now be inserted into the mouth of the urinal placed between the legs.

Special catheters have also been devised which are self-retaining (Malecot's or

Pezzer's, Figs. 151, 152, 153 and 154). Their bladder ends are wider than the rest of the instrument and they are introduced after stretching them upon a metallic mandrin. Personally, I never use these catheters, as I always fear that I may cause traumatism in inserting or withdrawing them, especially if the mandrin should happen to slip out at the perforated sides and thus injure the tissues. They often enter with difficulty and pain, and sometimes cause hemorrhage.

If the penis with the retained catheter is allowed to remain too long in one position, it is said that periurethral abscess or ulceration followed by a fistula may result. It is advisable, therefore, to change the position of the penis occasionally by placing the organ on the side of the abdomen and draining by siphonage into a bottle attached to the side of the bed, or into a urinal in the bed by the side of the patient. I often allow patients to walk about with a urinal between the legs. (See Fig. 155.)

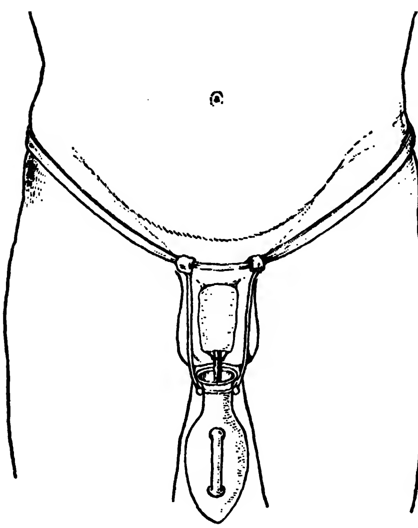


Fig. 155.—Glass Urinal between Legs.

When it is unnecessary to have continuous drainage and yet it is considered desirable to retain the catheter in the bladder, the instrument can be plugged and the plug withdrawn as often as necessary. With a plugged catheter, the patient is much more comfortable, as he can move about in bed and in many cases walk about. The plugged catheter may also be resorted to in cases of complete retention in which a large amount of urine has accumulated in the bladder and is being gradually withdrawn every two or three hours. In certain spasmodic cases, it may be desirable to keep the sphincter stretched until the spasm that is present has worn off, especially when the catheter has been introduced after a long series of trials.

INJECTIONS

Urethral injections are best given by means of a glass syringe with a conical nozzle holding two drachms, an amount which usually can be contained in the anterior urethra. In making an injection, the end of the glans should be held by the left forefinger in such a way that the meatus occupies the middle of the finger (Fig. 156). The end of the nozzle of the syringe is then inserted into the meatus; the forefinger is now contracted around the tip of the penis, thus pressing the end of the urethra containing the syringe

tip so firmly against it that the injection does not leak around the sides of the syringe and is contained in the urethra (Fig. 157). As the syringe tip is withdrawn from the meatus, the forefinger maintains its pressure on the end of the urethra, thus keeping the solution in the canal as long as desired (Fig. 158). Injections are usually retained for five minutes and are then allowed to escape.

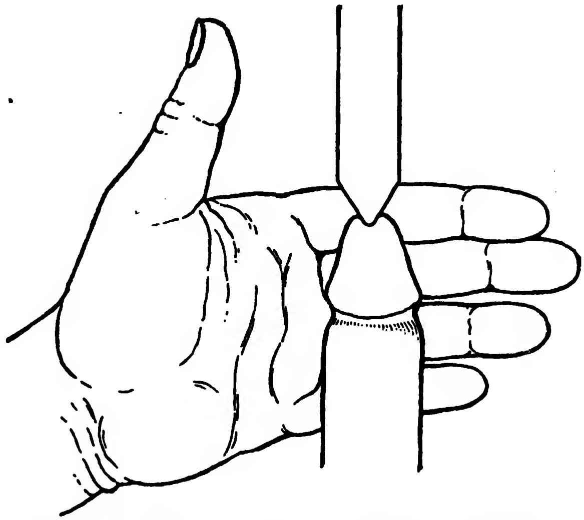


Fig. 156.—Relative Position of Meatus and Nozzle of the Syringe.

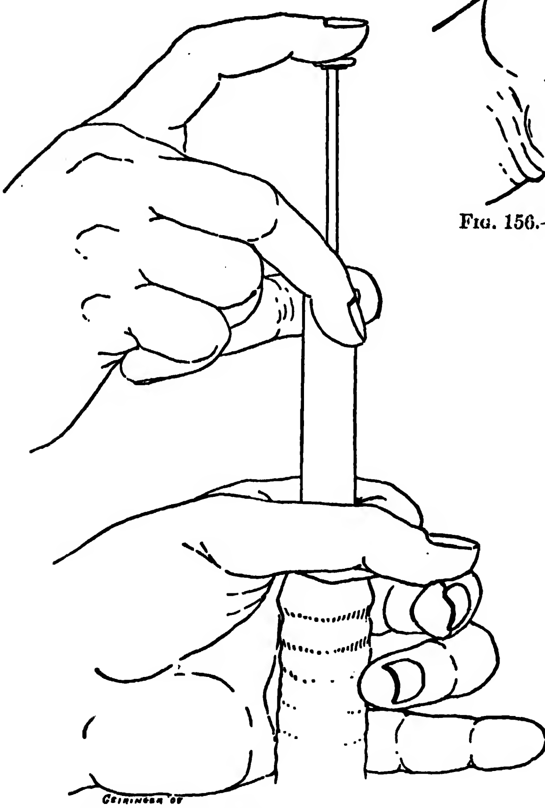


Fig. 157.—Manner of Holding the Nozzle of the Syringe in the Urethra.

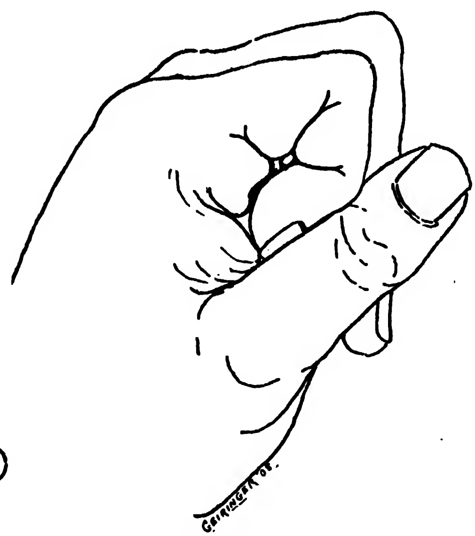


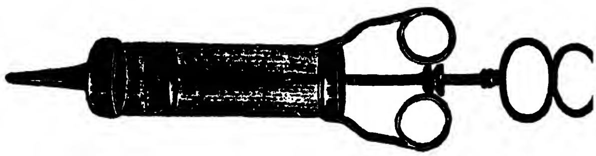
Fig. 158.—How the Solution is Held in the Urethra.
The meatus is seen in the bend of forefinger.

IRRIGATIONS

These include irrigations of the antero-posterior urethra and bladder or of the anterior urethra alone.

(*a*) **With the Piston Syringe Alone.**—The syringe is held in the right hand of the surgeon, while the meatus is compressed by the forefinger of the left

hand. The piston is pressed upon until the urethra is filled and inflated. The fluid can then either be held in or allowed to escape, and the canal then filled again. The fluid may be introduced into the posterior urethra and bladder by gradually increasing the pressure on the piston, thus overcoming the compressor urethræ and the vesical sphincter muscles. I am not in favor of this procedure and never use it.



'IG. 159.—A LARGE PISTON SYRINGE (BLADDER SYRINGE) USED FOR URETHRO-VESICAL IRRIGATIONS AND WASHIN OUT THE BLADDER THROUGH A CATHETER.

(*b*) **With a Piston Syringe and Catheter.**—If this is simply for the purpose of washing out the anterior urethra, the catheter is passed down to the bulb and the tip of the syringe is introduced into the end of the catheter. The solution is injected slowly and is allowed to escape along the side of the catheter. If the catheter is now pushed into the membranous portion, the fluid will still escape from the urethra, or will flow both into the anterior and posterior urethra. If the end is pushed into the prostatic portion of the canal, the membranous sphincter will prevent the fluid from escaping and after filling the prostatic urethra, the solution will pass into the bladder. The catheter, however, is commonly used in filling and washing out the bladder, in which case it is at once passed into the bladder and the organ is filled by the piston syringe. The fluid can then either escape through the catheter after the syringe is removed, or the catheter is withdrawn and the patient allowed to void the contents of the bladder, thus medicating the urethra.

FIG. 160.—CUT-OFF, NOZZLE AND SHIELD WITH A TUBE PASSING TO A DOUCHE JAR, FOR GIVING URETHRAL AND URETHRO-VESICAL IRRIGATIONS BY HYDROSTATIC PRESSURE.

(*c*) **With an Irrigator Working by Hydrostatic Pressure without a Catheter.**—The irrigation of the urethra without a catheter by hydrostatic pressure is very effective in treating urethral inflammation. For this

method it is necessary to have a reservoir containing the solution to be used. With this is connected a piece of rubber tubing to which is attached a nozzle, the tip of which is inserted into the meatus. The reservoir is then raised to a sufficient height to force the fluid to run into the urethra and as far as the back of the bulb. Pressure is then made on the tip of the penis, thus pressing the meatus against the nozzle. The fluid then passes into the urethra as far as the compressor urethræ muscle and escapes when pressure is removed.

THE JANET METHOD.—In case it is necessary to introduce the fluid into the prostatic urethra and the bladder, the reservoir is raised so that its lowest part is about a yard and a half above the pubes. The pressure on the meatus is

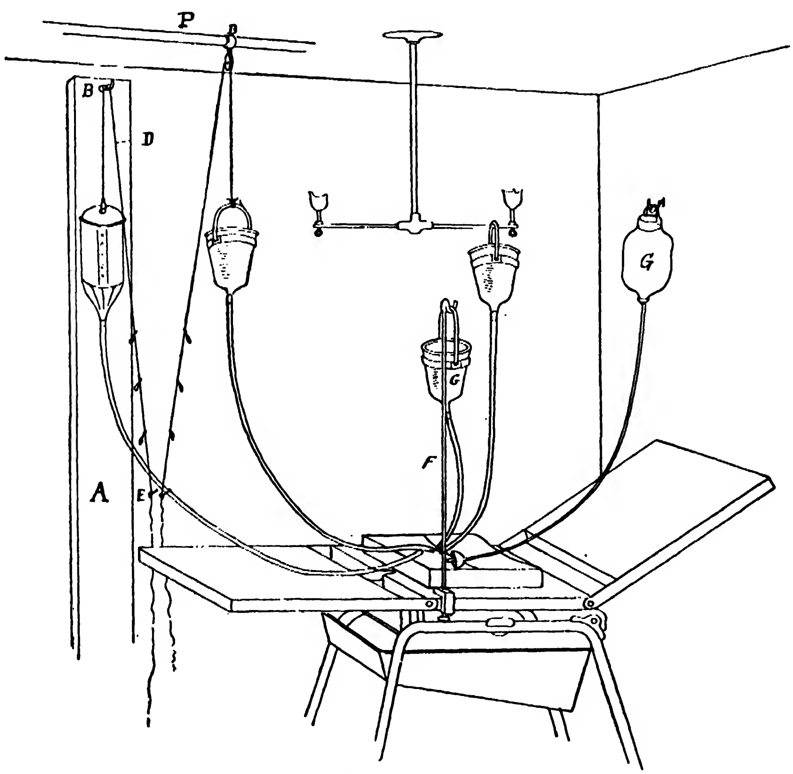


FIG. 161.—AUTHOR'S METHOD OF SUSPENDING DOUCHE JARS FOR IRRIGATIONS IN OFFICE, HOSPITAL AND CLINIC.

maintained and the patient is instructed to breathe deeply and try to relax all the muscles, or else to try to pass out the fluid that is in the canal. The effort to urinate relaxes the cut-off muscle and allows the solution to enter the bladder, after which the patient passes it out.

The douche jars vary in shape, but are usually conical. They are made of glass with a metal collar about the neck, to which is attached a metal bucket handle. This handle can be used to suspend the jar from a hook, or a cord can

be attached to it that is passed through a pulley by means of which it can be raised or lowered as desired. Other reservoirs are flat on one side and these fit better to the wall. Some of the jars are graduated. Rubber fountain syringes are used, but are not so easily sterilized and do not allow one to see the level of the fluid.

Various ways of suspending these jars have been tried by us in office and clinic practice. They are illustrated in Fig. 161.

A represents a board nailed to the wall, the door or a window frame. *B* is a hook to which is hung a pulley. *C* is the irrigator. *D* is a piece of cord, one end of which is attached to the handle of the irrigator. The other end runs through the pulley and is fastened to a cleat, *E*, on the wall.

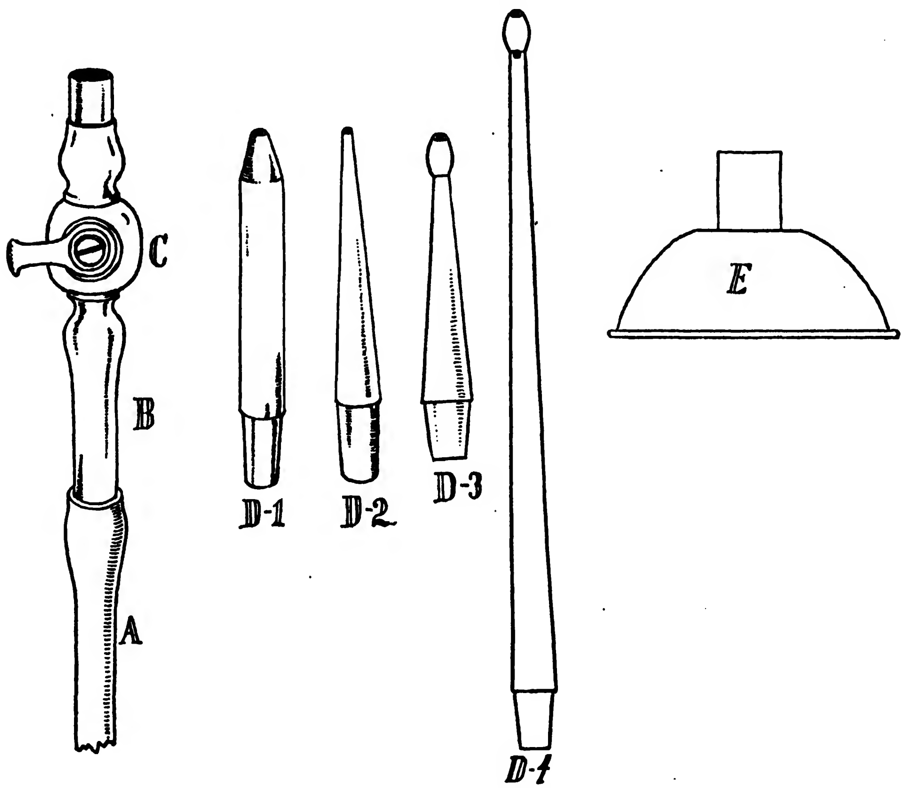


FIG. 162.—AUTHOR'S APPARATUS FOR IRRIGATING URETHRA AND BLADDER BY HYDROSTATIC PRESSURE.

P shows a gas pipe stretching across the ceiling of the room to which a pulley is attached at *B* by means of a wire. The cord runs from the irrigator handle through this pulley to the cleat, as has just been described. This second method has many advantages, inasmuch as a series of irrigators can be strung from one pipe.

F shows an upright fastened to the table which supports an irrigator. *G* shows a fountain syringe hung on a nail on the wall.

The object of the pulleys is to regulate the pressure of the fluid by raising or lowering the reservoir. If the jars are stationary, the force of the stream can be regulated by means of the cut-off to be described below.

The irrigator is connected by means of a rubber tube about three yards long with cut-off, shield and nozzle. The first figure (Fig. 162) shows (*A*) the rubber tube leading from the irrigator; (*B*) the hard-rubber coupling in which the nozzles (*D*) fit, and which is provided with a cut-off valve at *C*. This valve can be so regulated by pushing upon its lever that one can either shut off the solution or allow it to flow at different velocities. Over the body of the coupling, fits shield *E*, which is a cup-shaped guard intended to prevent the water from splashing or spilling. Into the coupling, *B*, fit the various nozzles provided for the apparatus, *D*-1, *D*-2, *D*-3 and *D*-4. *D*-1 has a blunt end suitable for irrigating the urethra by hydrostatic pressure. *D*-2 is elongated into a tip that can easily be inserted into a catheter. *D*-3 is a short nozzle, with an olivary tip, made for irrigating the fossa navicularis and *D*-4 is the same shape but long enough to extend to the bulb, for irrigating the bulbous portion of the urethra. It has also an olivary tip.

The shield, which is pictured in the figure (*E*), is the one I prefer in my own work. A number of shapes have been tried at my clinic at the Post-graduate Hospital. At first we irrigated without any shield, using simply hard-rubber nozzles at the end of the rubber tubing. We next tried round, soft-rubber shields with an opening through which the nozzle could be pushed. I have for many years used the copper detachable hemispherical shield, modeled after half of a hollow rubber ball, which I have found to be most satisfactory.

Fig. 163.—Irrigating Kollmann Dilator.

(*d*) **With Irrigating Dilators.**—Irrigating dilators are used for the purpose of irrigating the canal when it is dilated. They are of the Kollmann pattern, the dilating portion of which is composed of four blades. They can be used without sheaths or covers, such as are placed upon other dilators. They are straight or curved with a Béniqué curve. They are introduced into the urethra, their blades are separated by turning the wheel in the handle of the instrument. This smooths out the mucous membrane and opens the mouths of its follicles. The attachment is then made and the solution is allowed to run through, which thoroughly washes the urethra, while it enters the ducts, emptying into the canal as much as possible.

INSTILLATIONS

Instillation is the injection of a solution by drops into the urethra or bladder. This is done either with or without a catheter. The object of an instillation is to apply a strong solution to a definitely circumscribed portion of the

FIG. 164.—GUYON'S INSTILLATING SYRINGE.

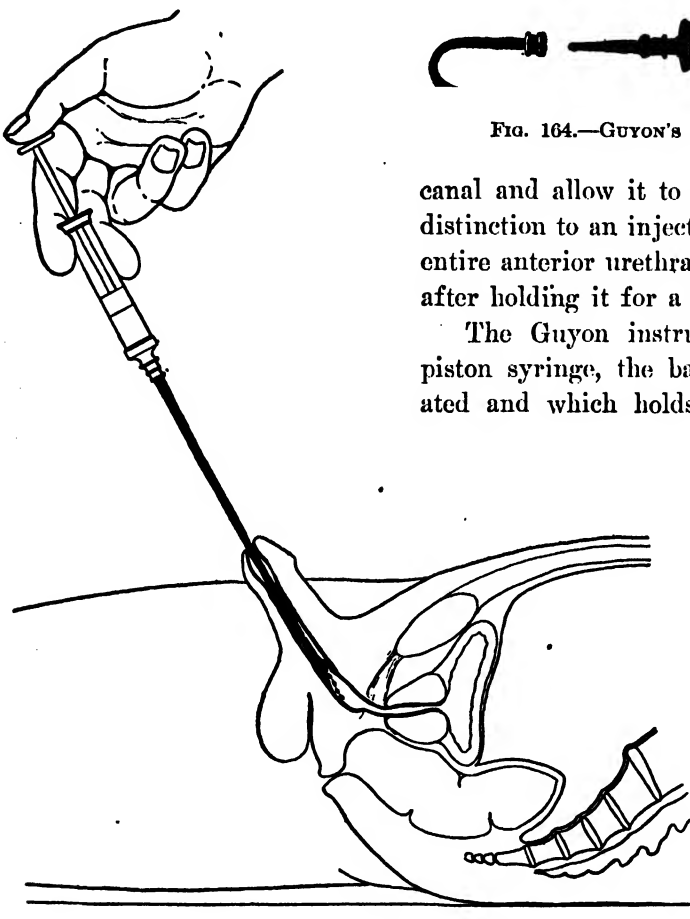


FIG. 165.—MANNER OF GIVING AN INSTILLATION OF THE URETHR WITH THE GUYON INSTILLATOR.

canal and allow it to remain there, in contradistinction to an injection, which acts upon the entire anterior urethra and is allowed to escape after holding it for a few minutes.

The Guyon instrument (Fig. 164) is a piston syringe, the barrel of which is graduated and which holds 4 grams (1 drachm). The tip of the syringe is attached either to an olive-ended, hollow bougie or to a catheter with a perforation at the extremity.

The Ultzman instrument is a piston syringe holding twenty drops attached to a curved, hollow sound (Fig. 166).

The solution used in instillations consists of silver nitrate, in the strength of from one to five per cent for the stronger effects or of 1:500 or 1:250 for milder action. Exceptionally, a caustic effect is obtained by the use of ten-per-cent solutions of silver nitrate. The amount of the latter is limited to three or four drops, while the weaker solutions are injected in quantities of from five to thirty drops. Other silver salts are used and will be considered in the chapter on Urethritis. Some surgeons use strong solutions of bichlorid of mercury and sulphate of copper for instillations, but I do not recommend them.

Instillations can either be given in the anterior or the posterior urethra. The method of procedure is as follows: The patient is allowed to pass his urine and the external parts are cleaned in the usual manner. For instillations in the anterior urethra Guyon's perforated, olive-tipped catheter is used and is introduced as far as the point of localized inflammation (Fig. 165). The tip of the piston syringe is then introduced into the outer end of the catheter and the fluid is slowly injected, from ten to fifteen drops being used.

In instillation of the posterior urethra, as practiced with the aid of the Guyon apparatus, the end of the catheter is passed into the posterior urethra and the solution deposited there in the same way.

Fig. 166.—Ultzman's Instillating Syringe.

The Ultzman syringe is, however, generally used for the posterior urethra. The hollow sound and the piston syringe are connected and the syringe filled with the solution. It is then passed into the posterior urethra like a sound and the solution instilled into it—usually ten to twenty drops. If the tip has reached the bladder, by rotating the instrument it can be felt to move freely about and it should then be withdrawn until it rests in the comparatively narrow confines of the prostatic urethra. In giving bladder instillations, either apparatus can be used, the end of the instrument being introduced into the urethra and the entire amount contained in the syringe instilled. Usually from thirty to sixty drops are instilled and left to act locally (Fig. 167).

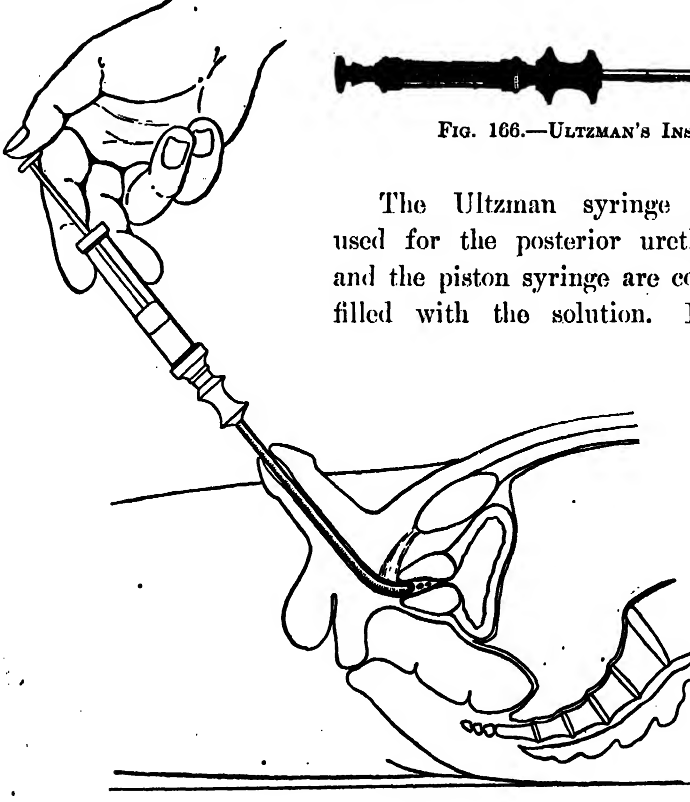


Fig. 167.—Manner of Injecting the Posterior Urethra by Means of the Ultzman Instillator.

SOUNDS

A sound is a metal instrument consisting of a shaft and a handle. The shaft is round, 8½ to 10 inches long, and tapers toward its distal end, which is curved

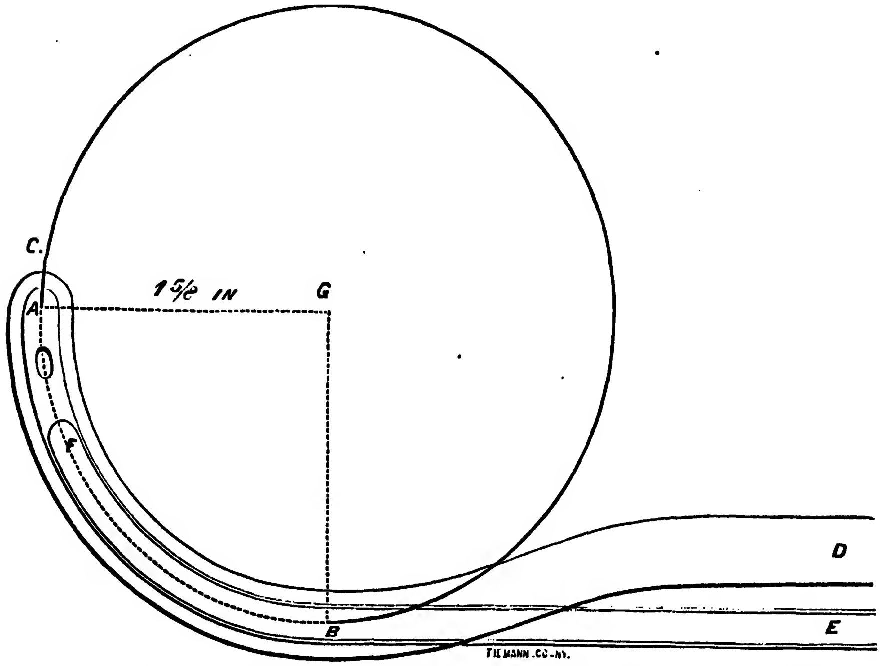


FIG. 168.—CURVES OF SOUNDS RECOMMENDED ARE *A*, *B*, *E*, VAN BUREN; *C*, *B*, *D*, BÉNIQUÉ; *F*, *B*, *E*, OTIS.

and well rounded at its tip. The handle is a piece of flattened metal, about 2½ inches long, wider in its transverse diameter and not so thick as the remainder of the instrument. The curve of the sound varies in its length and degree.

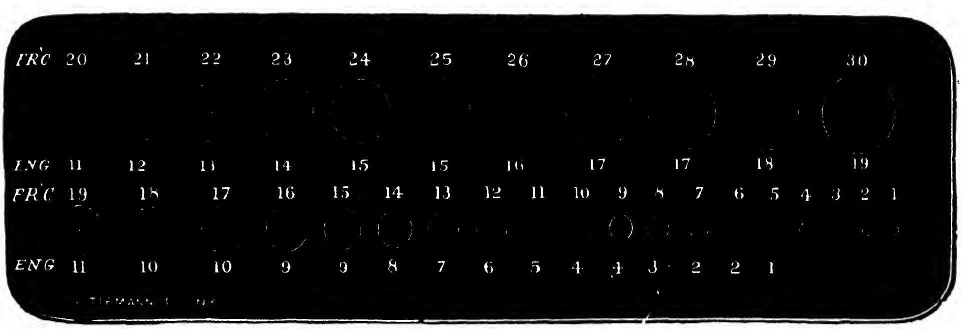


FIG. 169.—FRENCH (CHARRIÈRE) SOUND SCALE, COMPARED WITH ENGLISH MEASUREMENT.

There is the long curve, the short, the acute and the less marked. Straight sounds are also made, but are very rarely used.

The sounds principally used in this country are the Van Buren, the Béniqué and the Otis. The following diagrams illustrate these curves and arguments have been made in favor of each (Fig. 168). The short curve *FBE* is the one that I generally use in my urethral work, although, for the dilatation of hard strictures difficult of dilation, *CBD* is preferable, not on account of its shape, but because the difference between the sizes of the Béniqué sounds is only half what it is between the sizes of the other sounds of the ordinary French scale, the Charrière (Fig. 169). I also prefer the short curve because I believe that I can pass it more easily and feel the urethra better than I can with any other sound (Fig. 170).

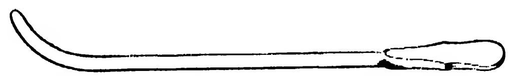


FIG. 170.—SOUND CURVE PREFERRED BY AUTHOR.

Technique of Passing Sounds.—This depends on the teaching in different countries and in different schools. In this country, the physicians pass sounds from the left side of the patient, whereas in Europe, they are passed from his right. The patient is placed in a reclining position, his body making an

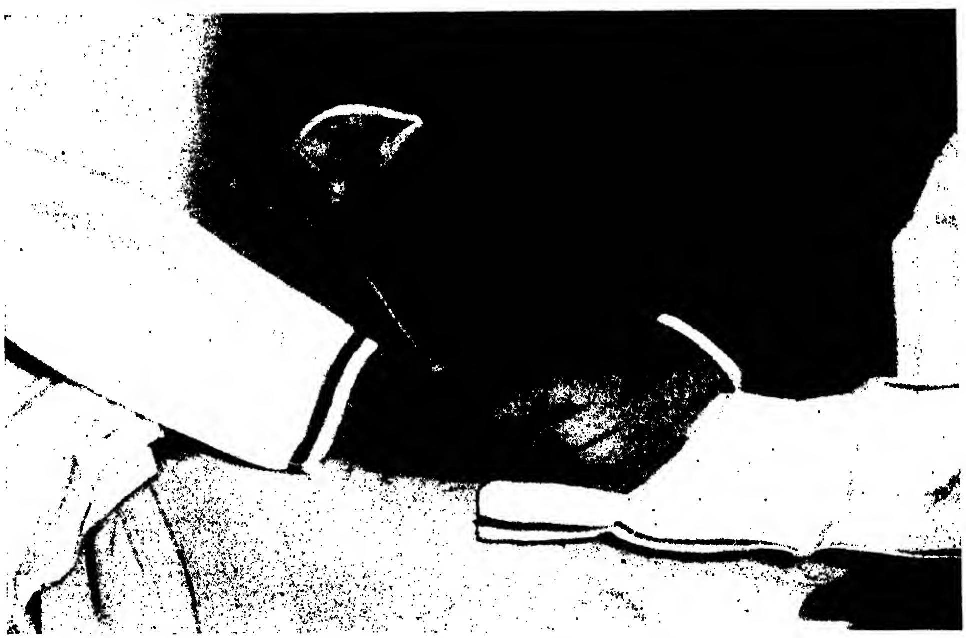


FIG. 171.—FIRST STEP OF PASSING A SOUND.

angle of about $22\frac{1}{2}°$ with the table. (1) The physician stands on the left side of the patient and grasps the handle of the sound between the thumb and forefinger of the right hand, while he grasps the penis with the left hand and holds it perpendicular to the body. He passes the sound over the thigh at right angles to its side and inserts its tip into the urethra (Fig. 171). (2) If the sound is of the proper size and is not held back by the operator, it should slide

down the urethra by its own weight as far as the bulb. The handle is then somewhat elevated and when the instrument ceases to glide, it should be swung

Fig. 172.—Second Step of Passing a Sound.

Fig. 173.—Third Step of Passing a Sound.

around gently toward the pubes until it is over the symphysis and the median line of the body, corresponding to the linea alba (Fig. 172). (3) The organ is then extended and steadied by the fingers of the left hand, while the right

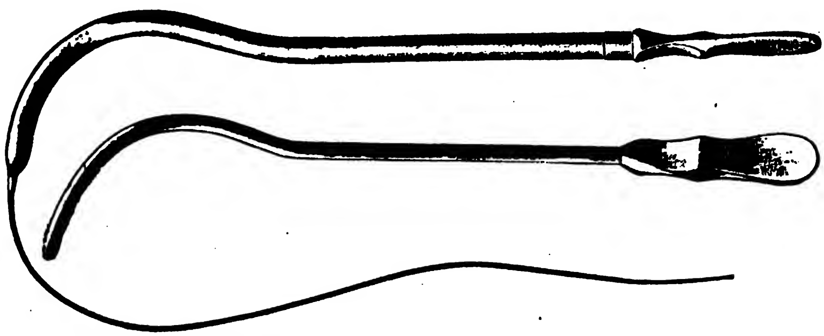


FIG. 174.—BÉNIQUÉ SOUND, WITH AND WITHOUT FILIFORM GUIDE.

hand gently moves the sound in the arc of a circle from the abdomen to between the thighs (Fig. 173). In passing the sound, the right hand simply

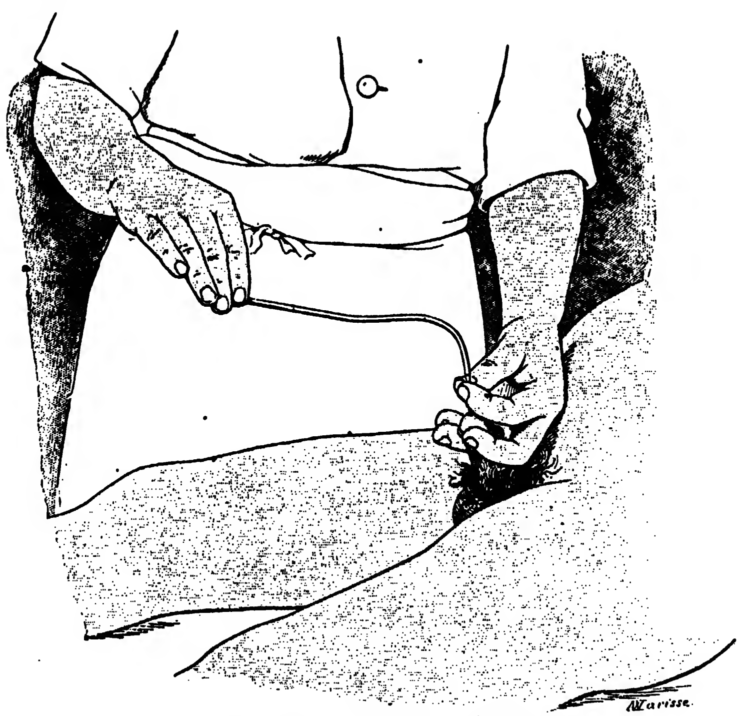


FIG. 175.—FIRST STEP OF PASSING A BÉNIQUÉ SOUND.

guides the sound, while the left hand keeps the organ fairly well on the stretch, so that the tip of the instrument, in passing the perineal part of the urethra, will hug the middle line of the roof of the canal and not catch along its course.

If the meatus is tight, the physician should pull the glans penis up toward

the handle of the sound from time to time, which will allow the part of the sound beyond the meatus to glide down farther into the canal. In this way, the hugging of the sound by the meatus can be overcome. A meatus smaller than the remainder of the canal should be cut.

In case the end of the sound catches in the perineal urethra and does not pass through its curve, this can often be aided by taking the instrument in the left hand and simply pressing over the pubes and suspensory ligament with the palmar surface of the fingers of the right hand. If this does not suffice, the fingers of the left hand can be placed in the perineum to steady and lift the end of the sound out of any pocket that it may happen to be in, up against the anterior wall of the urethra and in contact with the opening of the membranous urethra.

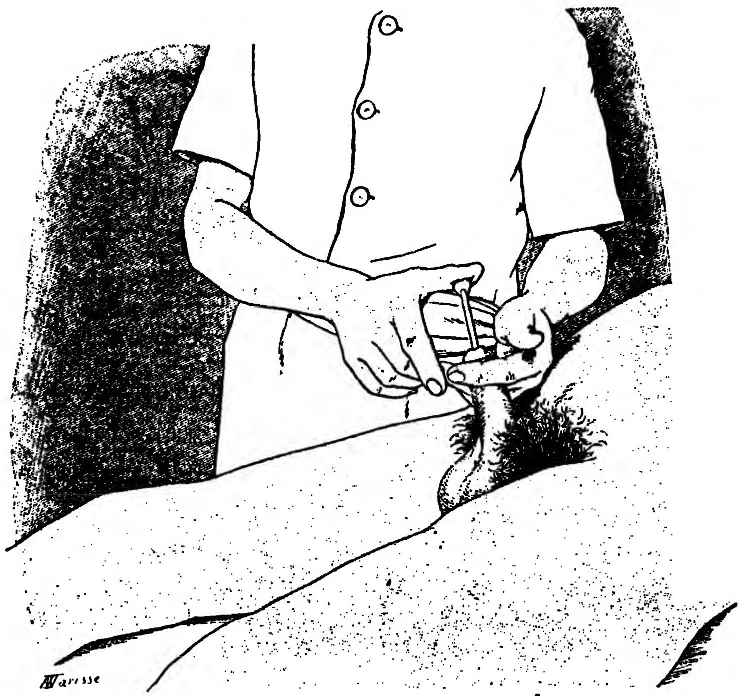


FIG. 176.—SECOND STEP OF PASSING A BÉNIQUÉ SOUND.

In France, the Béniqué sound, which has a long and pronounced curve like that of the perineal urethra, is principally used. These instruments are well adapted for stretching strictures, because they increase in size more gradually, by one sixth of a millimeter, instead of one third of a millimeter. They are used with a guide like a filiform bougie, fixed into a metal socket with a screw at the end (Fig. 174), which is screwed into a corresponding opening in the end of the sound (Fig. 174). The guide is passed through the urethra into the bladder, and the sound screwed on, after which the instrument is also introduced.

The French method of passing metal sounds is as follows:

(1) The operator stands on the right side of the patient, holding the penis with his left hand and the sound with his right, so that its concavity points to

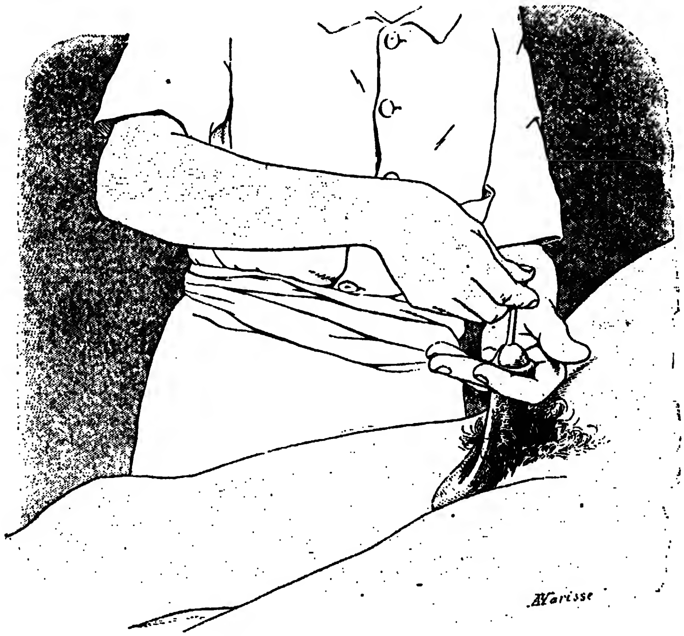


FIG. 177.—THIRD STEP OF PASSING A BÉNIQUÉ SOUND.

the right thigh (Fig. 175). He guides it down the urethra to the perineal portion, at the same time drawing the organ over the instrument around toward

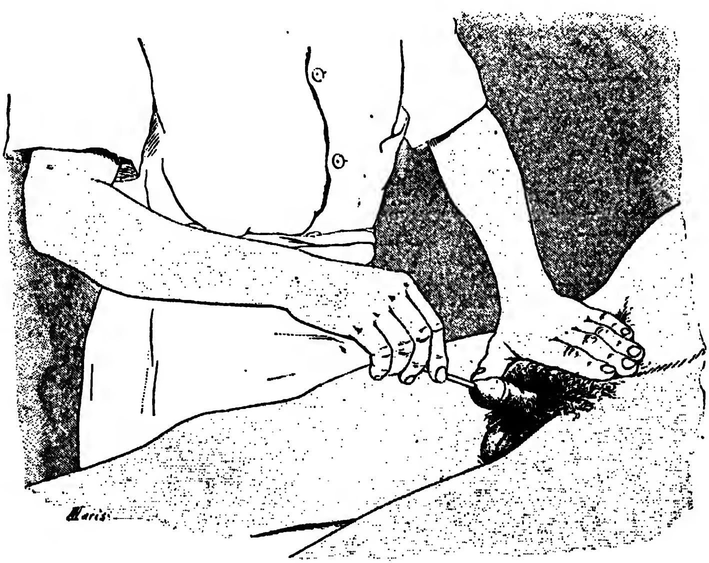


FIG. 178.—FOURTH STEP OF PASSING A BÉNIQUÉ SOUND.

the median line (Fig. 176). (2) The left hand then draws the organ up in front of the abdomen (Fig. 177). (3) When the end of the sound engages in the membranous portion, the left hand drops the organ and presses suprapubically over its suspensory ligament, while the right hand guides the instrument into the bladder (Fig. 178).

DILATORS

Urethral dilators are instruments shaped like sounds that can be enlarged by turning a *wheel* at the distal end, so as to stretch different portions of the canal. The shaft of the instrument, where the dilatation takes place, is composed of blades, bands of steel, that separate from one another either antero-posteriorly, or both antero-posteriorly and laterally, when the wheel is turned. A dial near the wheel registers the amount of dilatation.

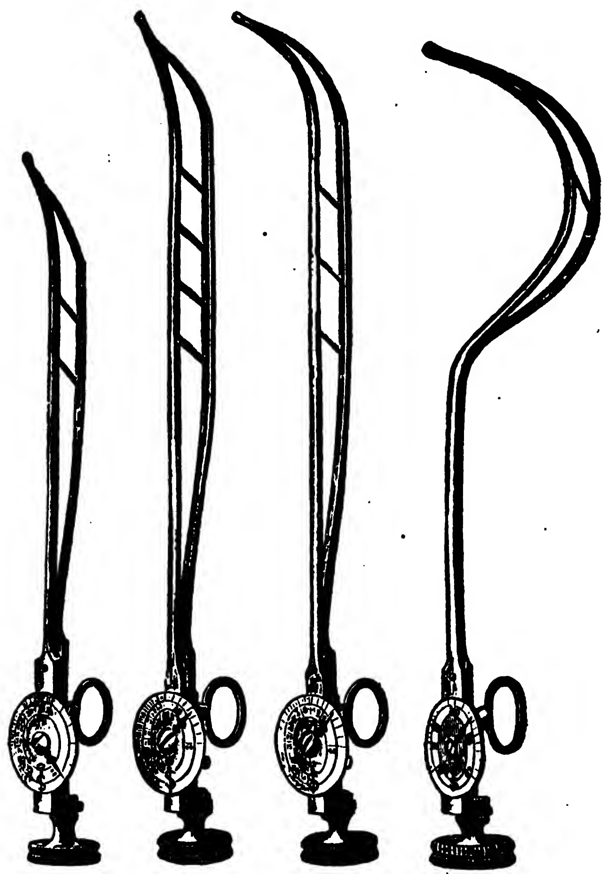


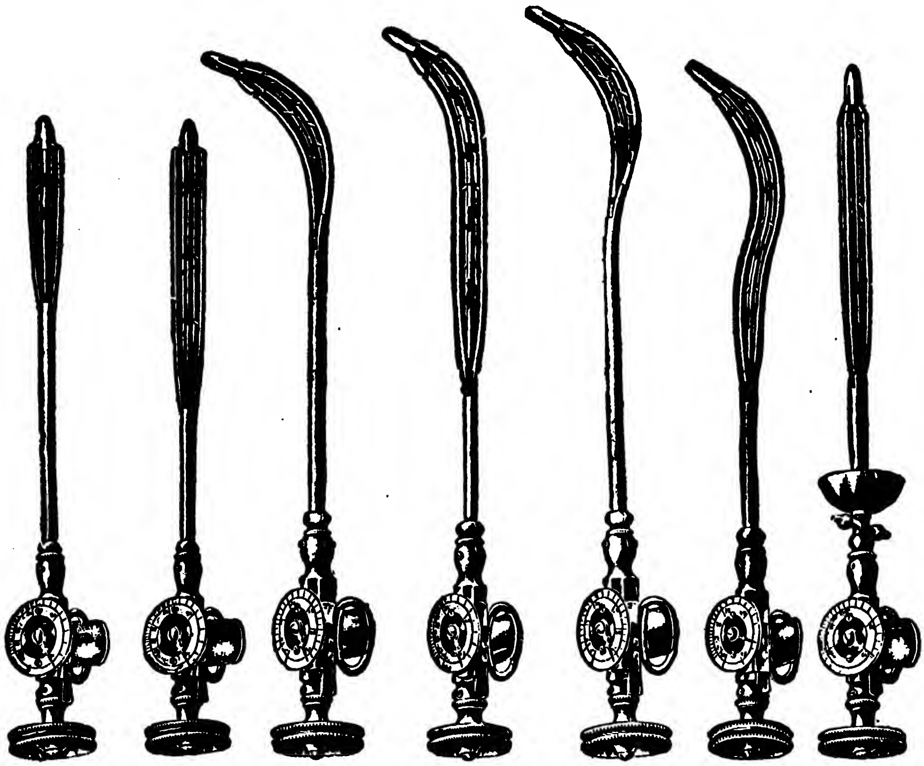
FIG. 179.—OBERLÄNDER DILATORS.

The instruments in which the bands separate antero-posteriorly are called the Oberländer, and the others in which they separate both antero-posteriorly and laterally, are called the Kollmann dilators.

The Oberländer dilator is of three forms, two with a flat curve for the anterior urethra (Fig. 179, Nos. 1 and 2), another with a curve like a sound for the antero-posterior urethra (No. 3) and the third with a more pronounced curve, Béniqué, for the posterior portion of the canal (No. 4).

Of these four Oberländer dilators, No. 3 is the best, as it can be used for the deep anterior urethra and the membranous and posterior portions by introducing it until the beak is in the bladder and then dilating. Or it can be used

simply for the dilatation of the anterior urethra, by inserting it and dilating, when the instrument is at right angles to the table. All these instruments, when they are closed, show no space between the two blades of the dilator.



No. 5. No. 6. No. 7. No. 8. No. 9. No. 10. No. 11.

FIG. 180.—KOLLMANN'S DILATORS.

Kollmann's straight articulated 4-bladed dilator for the anterior part of the urethra, with sl branches.

6. " " " " " " " anterior parts of the urethra, with long branches.

7. " curved " " " " " posterior part of the urethra.

8. " " " " " " " " and part of the anterior urethra.

9. " " " " " " " " part of the urethra, with Guyon's curve.

10. " double-curved " " " " " " and part of the anterior urethra, with Guyon's curve.

11. " straight " " " " " anterior part of the urethra, with irrigating attachment.

12. " curved " " " " " posterior and part of the anterior urethra, with irrigating attachment. (Shown in Fig. 184.)

The dilator of Oberländer (Fig. 179, No. 3) is composed of a shaft; of two pieces of steel, with three small levers between them; a handlepiece, composed of the body where the two pieces of steel come together; a screw connected with the wheel, at the end of the handle for separating the two pieces, of which the

instrument is composed; a metal loop for holding the instrument and a dial, which records the number of millimeters of dilatation. When the Oberländer is inserted, it is of the size No. 16 French, and when fully opened, No. 40 French.

The Kollmann dilators (Fig. 180) are worked on the same principle as the Oberländer, but, as they have four blades, they dilate on four sides and thus make more even distention. They dilate from 24 to 50 French. The posterior dilator, like the posterior Oberländer, has the Béniqué curve.

The *blades* of the Kollmann dilators are arranged in such a way that two blades lie at right angles to the other two, so that the cross section of the instrument at its widest point is shaped like a cross (Fig. 181).

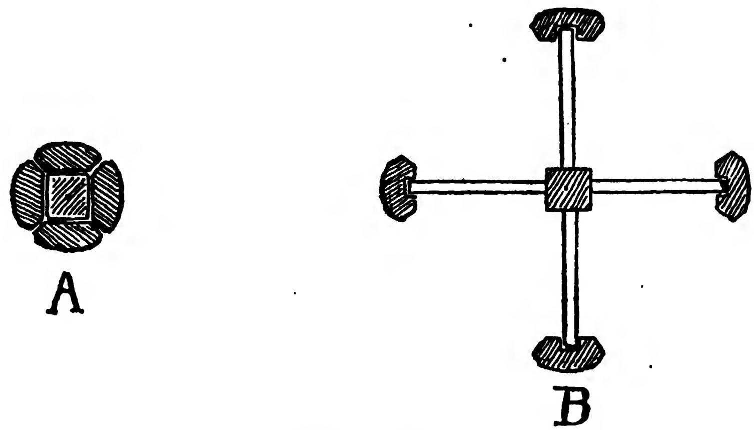


FIG. 181.—BLADES OF A KOLLMANN DILATOR.
A, cross section of blades closed. *B*, cross section of blades open.

These four-bladed dilators of Kollmann are made in three different types: Two straight Kollmann dilators, which are used only in the anterior urethra (Fig. 180, Nos. 5 and 6), two curved posterior dilators, which are used for the posterior urethra, as the blades separate only at the distal end (Fig. 180, Nos. 7 and 9) and finally, the dilators which dilate both the anterior and posterior parts of the canal (Nos. 8 and 10).

Of the Kollmann dilators without an irrigating attachment, if but one is to be used, the instrument with the curve like a sound for dilating both the anterior and posterior part of the urethra, No. 8, is the most useful.

The posterior Kollmann, No. 9, is also of great value, as in many cases of chronic prostatitis it is necessary to dilate the posterior urethra, and, as it is so much larger than the remainder of the canal, the necessary dilatation would not be obtained by means of an antero-posterior dilatation without danger of rupturing the anterior or membranous portion.

The varieties of instruments just described, both Oberländer and Kollmann, are all used with a rubber cover or sheath to prevent their blades from pinch-

ing the urethral mucous membrane when closing them and thus causing traumatism (Figs. 182, 183). The Oberländer with a curve like a sound (No. 3) is the best of the Oberländer group, while the antero-posterior Kollmann (No.

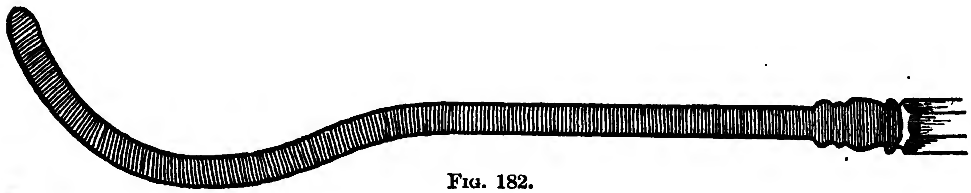


FIG. 182.

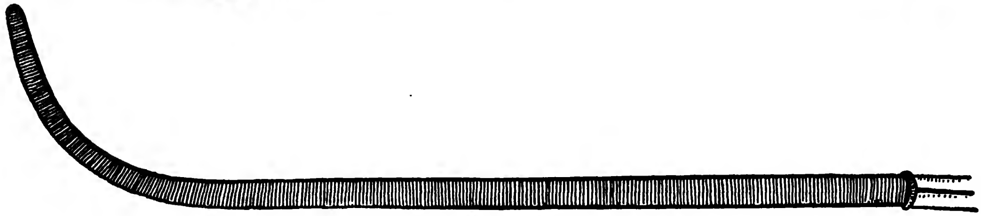


FIG. 183.

FIGS. 182 AND 183.—RUBBER SHEATHS DRAWN OVER THE DILATORS.

8) is the best of this group. Kollmann dilators are better than the Oberländer. The posterior Kollmann (No. 9) is the best instrument for stretching the prostatic portion of the urethra alone.

There are two other varieties of Kollmann dilators—one straight irrigating instrument (Fig. 180, No. 11), and another curved dilating instrument with an irrigating attachment (Fig. 184). These two instruments are naturally made to use without a cover and do not pinch the mucous membrane of the

FIG. 184.—KOLLMANN IRRIGATING DILATOR.

urethra, as when they are closed the blades touch only at their inner angle. The irrigating Kollmann has, in addition to the ordinary dilating instrument, a hollow shaft for irrigating purposes, and a bell or guard to catch the irrigating fluid as it escapes from the urethra.

Technique of Instrumentation.—The cover is drawn over the dilator. The instrument is then dipped into glycerin or some other sterile lubricant that mixes with water, such as lubrichondrin, and is passed into the urethra the same as a sound. The straight instrument is only passed into the anterior urethra until it is in a position perpendicular to the table (that is, at an angle of 90°), when the dilatation is made.

The antero-posterior and the posterior Kollmann are passed into the bladder

in the same manner as a sound and are allowed to remain in the position that they naturally assume, which is at an angle of about 45° with the table. The dilatation is made in this position.

The dilator is steadied by its handle with the fingers of the left hand, while those of the right hand grasp the wheel controlling the distention of the blades, and slowly turn it to the right until the degree of dilatation desired is indicated on the dial. But it must be remembered that if the patient complains of pain, or if any undue resistance is felt, the dilatation should not be pushed any farther. The dilator is left in place for a few minutes. It is then closed by turning the wheel in the reverse direction, after which it is gently withdrawn.

When the urethra is narrowed by a stricture, the No. 16 French Oberländer may be the only dilator that will pass it, and the first dilatation, therefore, will be up to No. 17 French. The average dilatation at the first treatment with the Kollmann dilator can be said to be about No. 25 French.

The rule is to increase at subsequent treatments by one or two numbers of the French scale each time. It must be remembered also that the two-bladed dilator of Oberländer causes more tension than the four-bladed one of Kollmann, and that, consequently lower degrees of dilatation must be begun with it. After a size of No. 32 or 35 French has been reached, the dilatation should be increased very slowly, indeed, a fraction of a degree at a time.

The duration of the dilatation at each treatment should be about ten minutes up to No. 32 French; about fifteen minutes from No. 32 to 36 French, and even longer with higher degrees of dilatation.

After dilating the urethra by means of dilators, the canal should be irrigated with some antiseptic solution, unless the irrigating Kollmann is used.

In using the irrigating Kollmann dilator (Fig. 184), it is passed in the same way as the other dilators until its curve corresponds with that of the urethra. The outflow tubing from the reservoir or douche bag is then connected with the nozzle on the handle portion of the instrument, and the solution runs through a central hollow shaft and escapes from slits in its sides, thus irrigating the urethra and running out along the sides of the instrument against the bell and then into a receptacle, such as a douche pan, placed beneath the patient's buttocks, or some other pan placed between the legs. It is a most satisfactory instrument.

The irrigating Kollmann dilator is of a rather complicated construction. It can be boiled, or at least its lower portions can be, and the mechanism at the handle is open so that it can be frequently cleaned and oiled.

The care of dilators is important, as the surgeon will find that, unless they are well cared for, they rust and get out of order. They should always be opened to their fullest extent after using, should be thoroughly cleansed and dried, especially at the joints and cross pieces, and should be wiped with a very

thin coat of vaselin and kept free from dust. Some prefer to clean the dilators, after they have been used, with liquid soap, and to wipe them with alcohol. The covers should be kept in a cool place, free from moisture and covered with talcum. Talcum can also be dusted into the covers before applying them to the dilators, but this is not a good plan, inasmuch as the powder clogs the joints. The dilators with their covers can be sterilized in a formalin sterilizer. With care a cover lasts about a dozen treatments.

CHAPTER IX

URETHROSCOPY

THE visual examination of the urethra through a metal tube by means of an artificial light reflected into it, or by means of a lamp in the distal part of the tube near its end, has been one of the greatest advances in modern urology.

Desormeux, in 1853, was the first to devise a urethroscope of any value. He used a tube illuminated by a lamp, the rays from which were thrown into the urethra by means of mirrors. Various other modifications were then made, using reflected light, until Nitze, in 1878, constructed an instrument which later became known as the Nitze-Oberländer, in which the urethral field was illuminated by means of a lamp in the tube. Since then, many modifications have been brought out, such as the Antal, Casper, Chetwood, Fenwick, Gorel, Klotz, Mark, Otis, Powell and Valentine, the most practical of which were those that had the lamp in the tube.

Urethroscopy was revolutionized and made simple by the introduction of the Mignon lamp by Drs. Koch and Preston of Rochester. This lamp was practically cold and was inserted into the tube on a carrier. Chetwood, Valentine and myself were among the first to use this variety of illumination in the urethroscope.

The urethroscope which bears my name consists of a tube six inches long and rounded at the distal end; but the remaining part of the tube, extending

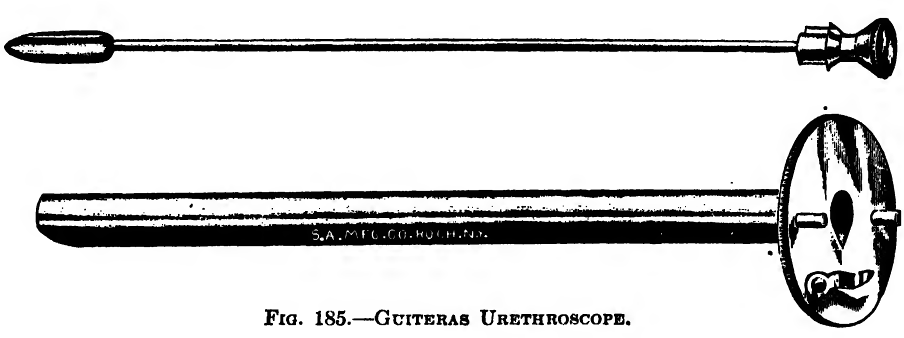


FIG. 185.—GUITERAS URETHROSCOPE.

from this point to the disk at its proximal end, has its lower arc transformed into a gutter which is not separated from the remainder of the tube.

The illuminating apparatus consists of a thin rod or wire carrier, at the

distal end of which is the Mignon lamp. At the proximal end of the carrier is the handle which has a switch for the light and two posts to which a cable is attached, the other end of which cable is connected with an electric current derived

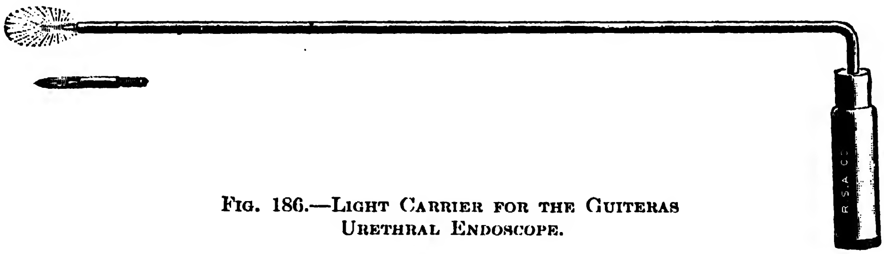


Fig. 186.—Light Carrier for the Guiteras Urethral Endoscope.

either from a portable storage battery or from the street. The turning of the switch lights the lamp at the end of the carrier. Along the gutter of the tube, the electric lamp, at the distal extremity of its carrier, is passed almost to

Fig. 187.—Portable Battery for the Guiteras Urethroscope

the end of the instrument. In this position it does not interfere with the view and yet it gives a perfect illumination of the urethral field. There are several

tubes, varying in size from 22 to 28 French. A tube of 28 French, or even larger, is preferable in urethroscopy.

The tubes of this urethroscope can be introduced into the deep and the posterior urethra with greater ease than those of any other straight instrument, on account of the rounding of the lower part of the tube when it curves over the bottom of the instrument.

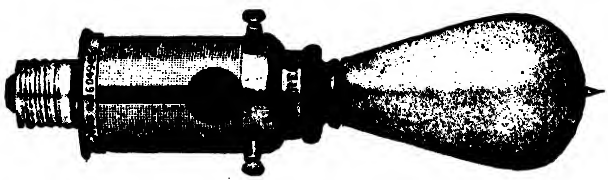


FIG. 188.—WAPPLER'S CONTROLLER FOR URETHROSCOPY AND CYSTOSCOPY.

The battery providing electricity for illuminating the urethroscope is one of from four to nine dry cells, provided with a rheostat controlling the current. Such batteries may be obtained in cases which have space for the carrying of urethroscopic tubes, light carriers and lamps and cables. Fig. 187 shows the battery made for the author's urethroscope. When the street current is available, a controller which regulates the current must be employed (Fig. 188). Care should always be taken to test the controller before making the connection with the lamp, as the rheostat at times burns out and when the little lamp is connected it is instantly destroyed by an excess of current. Another precaution in using the controller is always to turn off the current in the socket of the fixture to which the controller is attached as soon as the use of the apparatus is discontinued. This prevents overheating in the controller and prolongs the life of this appliance.

The battery or controller is connected with the light carrier by means of an insulated cord, the end of which fits into the hard-rubber handle of the carrier. A milled screw in the handle of the carrier shuts off or connects the lamp of the urethroscope.

In addition to the instruments, the source of light and the controller, the surgeon should provide himself with glycerin in a wide-mouthed vessel for lubrication and with a number of applicators about nine inches long. Metallic applicators are the best for both swabbing out the canal and making applications. The advantage of the metal applicators is that they have a special end which prevents the cotton from coming off in the tube and also because some of them are so fine near the end that, with a thin layer of cotton about them, they can be introduced into small areas for the application of solution.

A number of very useful instruments, for intraurethral treatment through the endoscopic tube, have also been devised by Kollmann and others. These include a pipette with a rubber bulb at its end for removing drops of secretion from the urethral glands; probes; silver cannulas which screw to a small syringe by means of which local injection of nitrate of silver can be made; a set of

minute knives for dividing strictures or urethral bands; and a urethral snare (Fig. 189).

Physicians who wish a special instrument for the posterior urethra will find one in the urethroscope of Dr. G. K. Swinburne of New York, constructed on

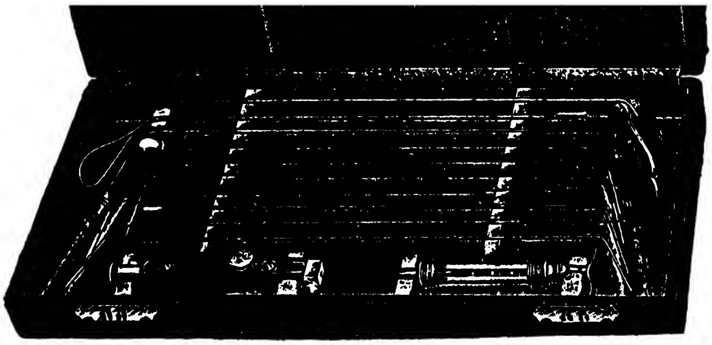


Fig. 189.—Case of Intraurethral Instruments.

Fig. 189a. Probe.

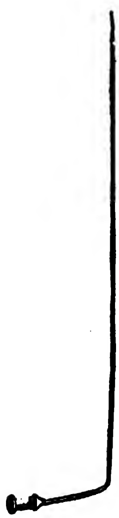


Fig. 189b.—Cannula Used for Injecting Glands and Follicles.

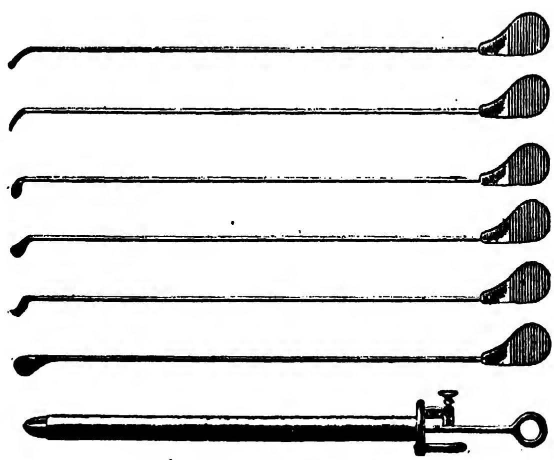


Fig. 189c.—Urethral Knives.

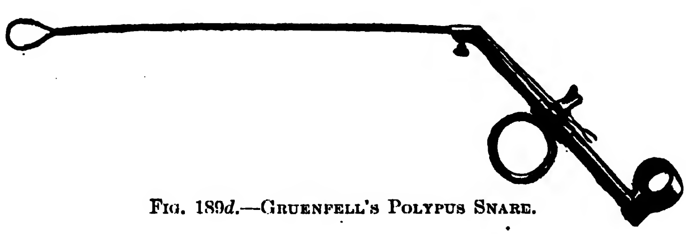


Fig. 189d.—Gruenfell's Polypus Snare.

very much the same pattern and by the same company. It is 16 cm. long and has a beak 2 cm. in length. The size used is No. 28 as a rule (Fig. 190).

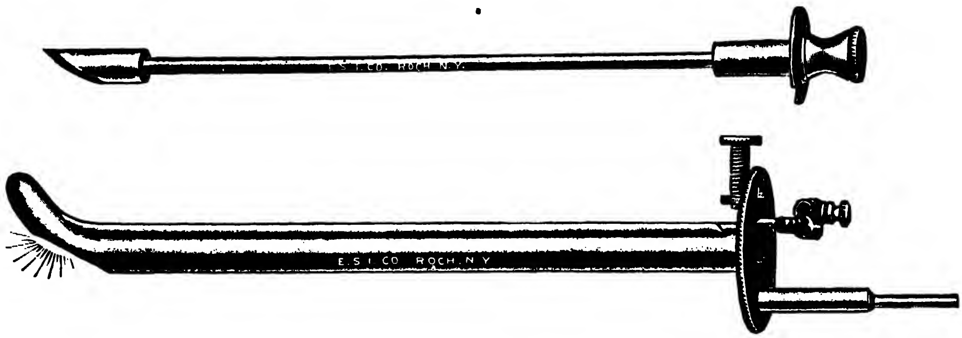


FIG. 190.—SWINBURNE'S POSTERIOR URETHROSCOPE.

The Buerger cysto-urethroscope gives a fine view of the prostatic urethra on all sides and is constructed on entirely different lines from the cylindrical

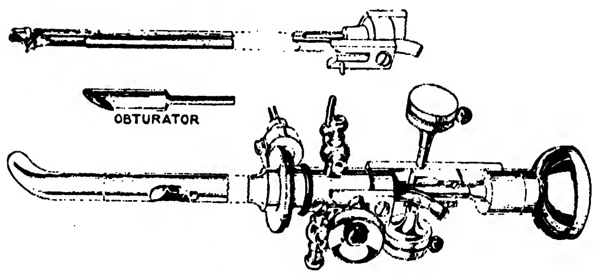


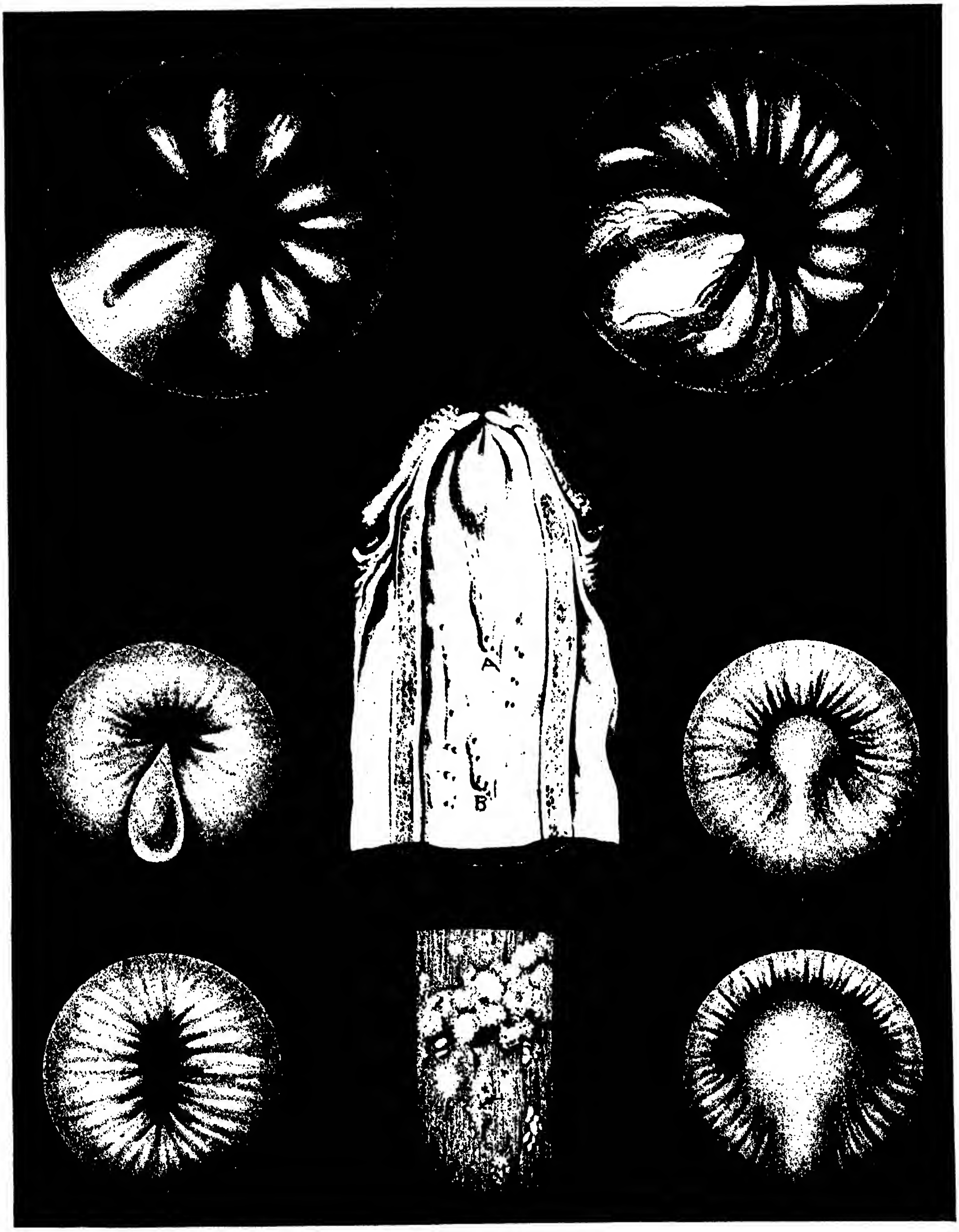
FIG. 191.—THE BRAUN-BUERGER CYSTO-URETHROSCOPE.

urethroscopes (Fig. 191). The ejaculatory and prostatic ducts, veru montanum and all portions of the prostatic urethra can be seen.

TECHNIQUE OF URETHROSCOPY

The patient is placed either in the dorsal position, with his shoulders elevated, or, if preferred, in a sitting posture with his body at an angle of $67\frac{1}{2}°$ with the table. His feet rest in inverted stirrups below the surface of the table on either side. If the urethroscopy is to be followed by cystoscopy, as it sometimes is, he can be placed at once in the cystoscopic position.

The examiner then sits in front of the patient between his legs. He takes the urethroscope with his right hand, in such a way that his thumb is on the obturator and his fore- and middle finger on either side of the tube behind the disk. He dips it into glycerin, opens the meatus with the thumb and forefinger of his left hand and inserts the tube into and down the urethra as far as the bulb, while he steadies and slightly stretches the penis with his left hand (Fig.



URETHROSCOPIC CONDITIONS.

FIG. 1.—Appearance of the urethra after a course of treatment by electrolysis.
FIG. 2.—Angioma of the urethra occupying only a segment of the canal.
FIG. 3.—Pedunculated polyp of the urethra.
FIG. 4.—Normal veru montanum, anterior portion.
FIG. 5.—Normal view of the urethral bulb.
FIG. 6.—Normal view of the largest portion of the veru montanum.
FIG. 7.—Longitudinal section of the normal urethra, showing the fossa navicularis above; two large urethral follicles (crypts of Morgagni) lower down. Numerous orifices of smaller follicles are also seen, showing the difficulty of thoroughly treating all these small openings when involved in chronic urethritis.
FIG. 8.—Conglomerate polypoid granulations.

192). If an examination of the posterior urethra is also desired, the distal or ocular part of the cystoscope should be depressed and the instrument pushed

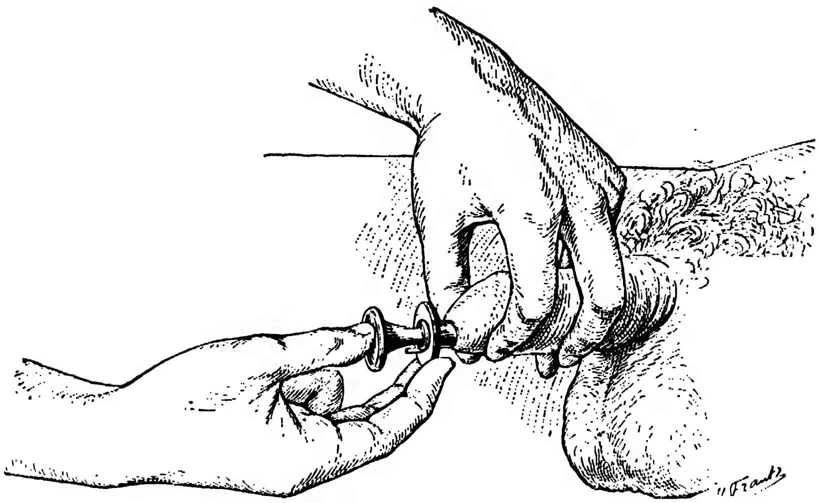


FIG. 192.—MANNER OF INTRODUCING THE URETHROSCOPE. (After Luys.)

gently through the membranous portion into the posterior portion. A swab is then introduced into the tube to dry up the glycerin or any urine that may be

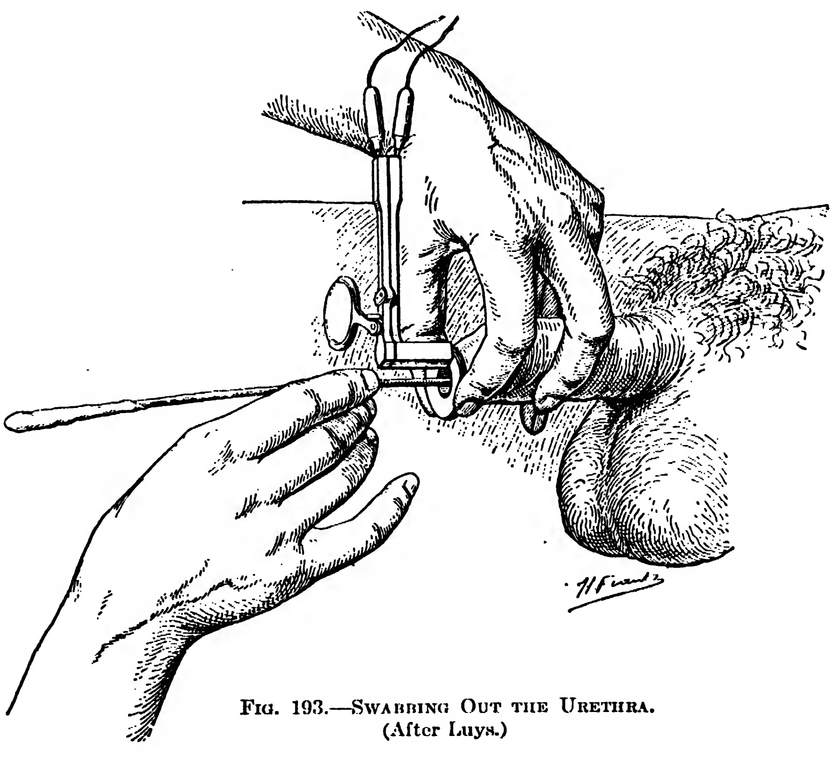
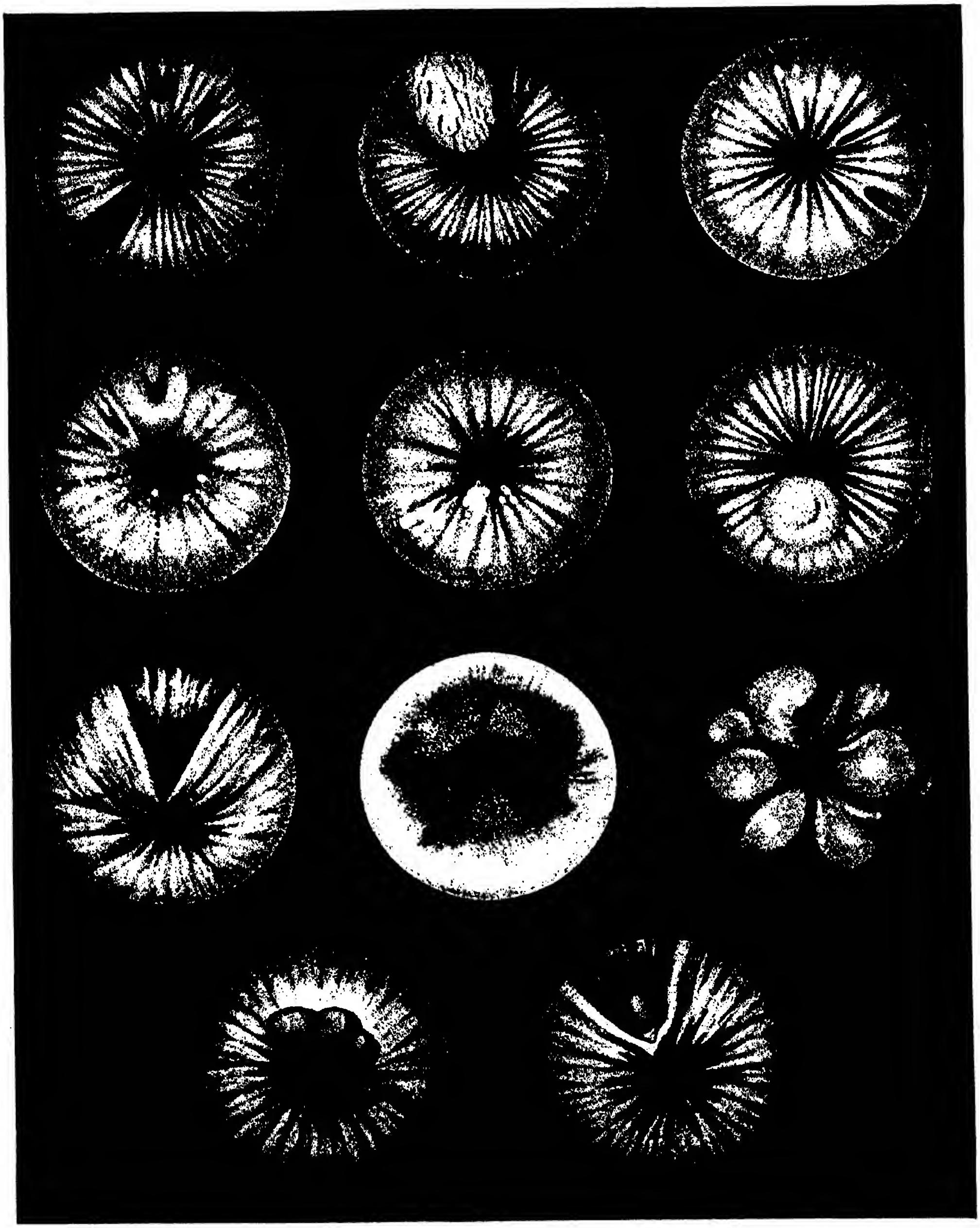


FIG. 193.—SWABBING OUT THE URETHRA.
(After Luys.)

obscuring the field. The swabs are made by winding sufficient cotton around the end of an applicator to have a wad one sixth to one quarter of an inch in diameter. Several of these should be always ready to use in doing urethroscopy. The canal is swabbed until dry (Fig. 193). The lamp and its carrier, with the cable attached, is then introduced into the tube and fastened to the pins on the disk. The current is then turned on, and the examiner puts his eye to the ocular end of the tube and proceeds to inspect the urethral field, holding the urethroscope with the right hand and the organ with the left. Fig. 194 shows the position for examining the anterior urethra, whereas Fig. 195 shows the position for examining the posterior part of the canal.

FIG. 194.—POSITION IN EXAMINING THE ANTERIOR URETHRA. (After Luys.)

The Normal Urethra.—In order to make a correct diagnosis of urethral lesions with the aid of the urethroscope, one must be thoroughly familiar with the normal urethra. An important fact to bear in mind is that the urethra varies normally in appearance, both according to the degree of anemia and hyperemia, and according to the particular part which is under observation. It may be pale red, moderately red or deep red. The paler tints have sometimes a grayish or a yellowish tinge. The pressure of the urethroscopic tube, especially when it is too large for the canal, and when it presses against one



URETHROSCOPIC CONDITIONS.

FIG. 1.—View very frequently seen of the crypts of Morgagni, urethral follicles and chronically inflamed glands of Littré.

FIG. 2.—Chronically inflamed crypt of Morgagni which can be cured only by applications of electrolysis.

FIG. 3.—Appearance of Littré's glands during a chronic suppurative process.

FIG. 4.—Combined cystic and suppurative condition of the glands of Littré. This shows the necessity of dilatations in such a condition.

FIG. 5.—The same condition as in Fig. 4.

FIG. 6.—A very large cyst of Littré's gland which gave way under dilatation.

FIG. 7.—Normal appearance of a large crypt of Morgagni of a "V" shape.

FIG. 8.—Stricture of the urethra. Mucous membrane is seen to be darker with rigid walls invaded by fibrous tissue. Very inelastic.

FIG. 9.—Soft infiltrate of the bulbous urethra, a typical case. There is a puffiness resembling hemorrhoids.

FIG. 10. Sessile polyp in the bulbar region.

FIG. 11. Small polyp situated on the edge of a large crypt of Morgagni.

side of the urethra, produces a local anemia which the beginner must learn to recognize.

Various regions of the urethra present certain important features which must be remembered. Near the glans, that is, in the region of the fossa navicu-

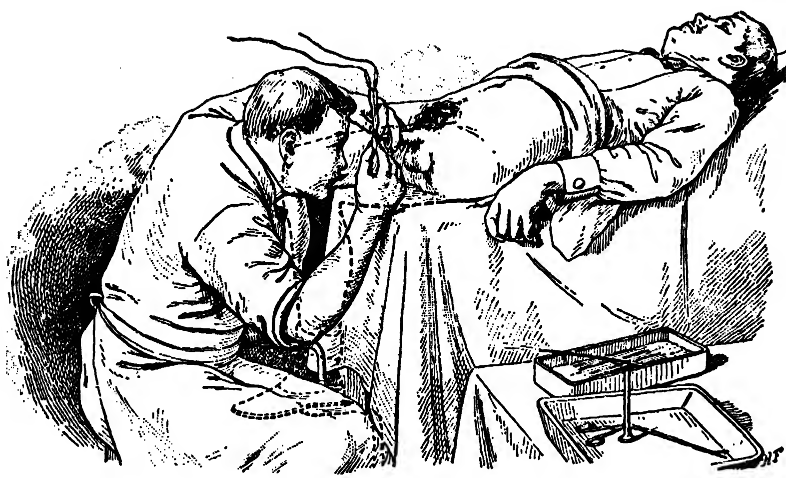


FIG. 195.—POSITION IN EXAMINING THE POSTERIOR URETHRA.
The left thigh has been removed to better show the position.

laris, the lining of the canal is very pale and smooth. Beginning with the region behind the fossa and extending throughout the anterior urethra, the mucosa is thrown into longitudinal folds which are necessary for allowing the canal to be distended when filled with urine. The size of these folds varies in different individuals, as does the size of the penis and the urethra. The longitudinal folds appear in the urethroscope between radiating lines from the central depression which represents the lumen of the canal. Frequently the pressure of the tube so distends these folds that they are more or less obliterated.

As the urethra, when undisturbed, is in a collapsed state, the introduction of the tube widens the part immediately behind the end, that is, the part we are looking at in the form of a funnel whose narrow portion is constituted by the lumen of the undisturbed part of the canal. If we look into the tube, therefore, and if we hold it so that the lumen is central, we are looking into the funnel whose walls are formed by the radiating folds of the spreading mucosa. The latter are, naturally, most marked toward the bottom of the funnel and are obliterated where the edges of the tube touch the mucosa. The central depression at the bottom of the funnel should always be carefully noted, as it varies considerably. Thus, in the bulb where we begin the examination, the inferior wall of the funnel bulges upward so that there is a central depression shaped like a Y whose angles are rounded. As we advance into the cavernous part of the urethra, the central depression becomes smaller and forms either a horizon-

tal slit or a small circular figure. Finally, in the region of the glans the lumen assumes the shape of a vertical slit which sometimes appears as an oval figure.

In addition to the folds, we have in the normal urethra certain radiating striations which are specially noticeable in the cavernous portion when there is a good blood supply and when the urethroscopic tube is sufficiently large. These striations are of a pale or yellowish red. In persons with robust constitutions and plentiful blood supply, one also sees minute branched vessels coursing through the mucous membrane.

In the normal urethra, the surgeon should learn to distinguish three kinds of glandular openings: (1) The mouths of the ducts of Cowper's glands. These are not always visible, but should be looked for in the lower wall of the bulbous portion, at the bottom of the folds of the mucosa. (2) The urethral follicles are widely scattered over the anterior wall (upper wall) of the urethra and should be looked for in the cavernous or bulbous portions by gently pressing the mouth of the tube against the anterior wall and carefully going over the canal. They look like minute depressions of the size of the head of a pin or smaller, sometimes of the same color as the mucosa around them, but oftener of a dark red with a still darker center or depression. We shall see that, in chronic urethritis, they may be materially altered. (3) Littré's glands, which are very numerous and scattered throughout the canal, are only visible when diseased, but they remain in evidence a long time after the urethritis is cured.

All these different characteristics of the normal urethra are far less evident in anemic and debilitated individuals than in persons with robust constitutions.

It must be remembered that, when it is desirable to examine the posterior urethra, this should be done before examining the anterior portion of the canal by inserting the instrument at once through the membranous into the prostatic portion. The urethroscope is then slowly withdrawn, examining from behind forward, as has been described.

Pathological Conditions.—Other important factors in urethroscopy include the localization of lesions along the canal in urethras of large size in which no strictures are present. One of the important lesions which should be detected with the urethroscope, if present, is a polyp of the mucosa for which urethras are frequently dilated for a long time, under the impression that it is a narrowing of the canal. Simple and tubercular ulcers, erosions, granular patches and the dilated glandular ducts can also be seen.

Tubercular ulcers occur in the urethra, although rarely. Soft and hard chancres are always situated near the meatus and can be easily seen without the urethroscope.

In strictures, urethroscopy serves to show the narrowing and the presence near by of chronic congestion or inflammation. Unfortunately, the tube which has to be used in most cases of stricture is so small that it does not allow us to examine the field very minutely.

Urethroscopic Treatment of Pathological Conditions.—Foreign bodies in the urethra can be detected through the urethroscope and occasionally removed by introducing alligator forceps, grasping them and pulling them out through the tube. Polyps can be removed from the urethra by means of a snare; ulcerated surfaces and granular patches can be curetted and cauterized; the dilated ducts of urethral glands can be cauterized and destroyed by electrolysis or slit up with minute knives.

Urethroscopy is of great value in the diagnosis of the lesions of chronic urethritis, showing as it does the stage of the disease and the type of the lesions present. This subject, however, is discussed in the chapter on Chronic Urethritis, to which the reader is referred for further particulars.

There is a certain amount of difficulty in learning to do urethroscopy and in interpreting what is found. The procedure requires much patience, practice and precision. In order to become skilled in it, one must examine a large number of cases, remembering always that the introduction of the urethroscope is contraindicated in all acute conditions. It is a question whether urethroscopy is of such great practical importance as has been stated by some authors. In the majority of cases, I have gained nothing from my examinations with the urethroscope and have often felt that the work has been a loss of time. In most instances, nothing is seen but a slightly granular condition of the urethra in certain localities, or else areas of chronic inflammation which can only be treated by dilatation and irrigation. Occasionally we see something of importance like a polyp of the urethra and then we feel how important it is to urethroscope all patients with chronic urethral trouble as a matter of routine.

CHAPTER X

CYSTOSCOPY

Cystoscopy is at the present day a practical procedure. During the last twenty-five years of the nineteenth century, many investigators who were interested in urinary diseases were bending their energies to discover some instrument that would reveal to them the character of the interior of the bladder and the ureters leading to the kidneys. When such instruments were finally made practical, the advance became very rapid, so that to-day the bladder can be explored by every conceivable visual apparatus; and, although we can see what we consider necessary for us in urinary work, the probabilities are that in a few years this procedure will be looked upon as crude and behind the times. It is well to consider what cystoscopy is; the different instruments that were used in the past and are used at present, as well as the details of performing cystoscopic examinations.

The *cystoscope* (from *cystis,* bladder and *skopein,* to view) is a tube fitted with lenses, or lenses and prisms, for viewing the interior of the bladder when illuminated with an electric lamp.

While cystoscopy is essentially a method of examining the bladder, it also shows the vesical aspect of the prostate and, through the inspection of the ureteral orifices and the urine coming from the ureters, it aids in diagnosing diseases of the kidneys.

It must always be borne in mind that the *object of cystoscopy* is to examine the bladder, and that it is not done for the purpose of catheterizing the ureters, unless clinical and urinary evidence point to ureteral or renal involvement.

HISTORY OF CYSTOSCOPY

The early attempts at cystoscopy were combined with those to illuminate the urethra. The first of these dates from 1805, when Bozzini, of Frankfort, invented an apparatus which was meant to illuminate the urethra and bladder. A number of attempts of similar character were made with little success until Desormeux, Furstenheim and Cruise (1853–65) constructed the first endoscopes that made an examination of the bladder possible. In 1867, Brück, a dentist in Breslau, devised an instrument for examining the mouth, called

a stomatoscope, which was illuminated by means of an incandescent platinum loop, heated to white heat by means of a galvanic current, and later constructed another for examining the bladder, called a diaphanoscope. Although it was found to be unpractical, it is interesting, because the Nitze instruments, which are now in use, are constructed on the same principles.

In 1876, Nitze devised an electric cystoscope and urethroscope, and demonstrated the instrument in 1877. This cystoscope was later improved and simplified by Leiter of Vienna, so that the first electric cystoscope bears the name of Nitze-Leiter and the date of 1879. The lighting device of this cystoscope was also an incandescent platinum loop which was surrounded by a stream of water so as to keep the end of the instrument cool. A flow of water was necessary to keep the temperature of the beak of the instrument below the danger line. The original Nitze-Leiter cystoscope was complicated, cumbersome and unsatisfactory in many respects.

In 1879, Edison first patented his incandescent lamp, which revolutionized the methods of constructing illuminating instruments in general and cystoscopes in particular. Since then, the incandescent lamp system has been used in cystoscopy.

In 1887, came the introduction of the cystoscopes of Nitze and Leiter, both constructed on similar principles, and also the direct cystoscope of Brenner, which have served as models for all the cystoscopes since devised. These cystoscopes had shafts shaped like a coudé catheter and were of the observation type for viewing the interior of the bladder through a water medium.

Catheterization of the Ureters.—The steps leading up to the catheterization of the ureters began at about the time that Nitze, Leiter and Brenner had perfected their observation cystoscopes in 1887 and were not associated with cystoscopy.

Iverson, in 1888, began to catheterize the ureters by opening the bladder suprapubically and thus reaching their mouths, while Bozeman reached them through a vesico-vaginal opening; these procedures were in the line of major operations and consequently dangerous in character.

At about the same time, in the development of ureteral catheterism, Pawlick (*Wiener Med. Presse*, 1886) found that, by placing a woman in the genu-pectoral position, he could lift up the posterior vaginal wall with a speculum and expose to view the anterior wall; then, having introduced a catheter into the bladder, he could guide the point of the instrument by his finger in the vagina until it reached the ureteral orifice, when he could push it into the ureter. This procedure was exceedingly difficult of execution, rather dangerous on account of the blind manner in which it was performed, and, of course, only applicable in women.

Later, Kelly, of Baltimore, modified the method that had been employed without much success by Pawlick and devised a method of catheterizing the

ureters, familiar to us all, which consisted in passing a tube through the urethra into the bladder, illuminating its interior by reflected light from a head mirror, and searching for the ureters with the aid of a long stilet which served to unfold the bladder. When the ureteral orifices had been found, the stilet was replaced by a catheter.

It was not, however, until 1892 that catheterization was performed through a cystoscope and then by means of the direct instrument. The first of these was that of Brenner in 1892; then that of Nitze in 1895, of Casper in 1896 and finally the Nitze-Albarran in 1897.

A COMPARATIVE CONSIDERATION OF MODERN CYSTOSCOPES

Having gone over our historical review and found that the principal men to whom we are indebted for early knowledge of the examination of the bladder were Nitze, Brenner, Fenwick, Pawlick, Kelly, Casper and Albarran, let us consider the later work along these lines.

We will put first on our list Brenner and Nitze, as the two leaders in the respective lines of direct and indirect cystoscopy.

Brenner's direct instrument (Fig. 196) was perfected in 1887 and was the first direct-observation cystoscope of practical value for examining the bladder

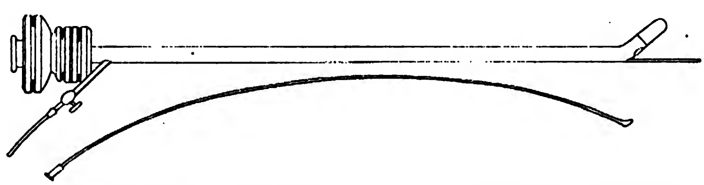


Fig. 196.—Brenner's Observation and Catheterizing Cystoscope.

through a water medium. The instrument had an optical apparatus consisting of a telescope, which looked straight into the bladder without requiring any prisms to reflect the image.

The First Direct-Observation, Irrigating and Catheterizing Cystoscope.—In 1892, Brenner added a small separate compartment on the convex side of his instrument which contained a mandrel. The mandrel could be withdrawn and the bladder washed out through this channel, or a catheter could be introduced through it into a ureter. The instrument could also be slipped out over this catheter, leaving it in the ureter. It was for a long time considered the best instrument for ureteral and kidney work in women. The Brenner instrument was thus transformed from an observation cystoscope to an irrigating, and a single catheterizing cystoscope, which marked the greatest achievement up to that time in cystoscopy.

The Indirect Cystoscope.—The steady improvement of the indirect instrument in the hands of Nitze, Casper, Leiter, Fenwick and others, made the

indirect cystoscope of the Nitze type more useful than the direct. The advantage of the indirect instrument was that a better view of the whole bladder interior could be obtained, especially of the anterior wall.

The Construction of the Nitze Cystoscope.—The Nitze cystoscope (Fig. 197) consists of an elbowed tube, having at its vesical end, in the elbow,

Fig. 197.—Nitze's Observation Cystoscope.

an electric lamp, contained in a metal sheath which is fenestrated upon its anterior surface. Close to the elbow, upon the upper surface of the straight portion of the tube, is a prism, which lies so that the hypothenuse, which is silvered, forms a mirror and reflects the rays of light entering the prism from the bladder into the lumen of the cystoscopic tube. In this, by means of an arrangement of lenses similar to those of a telescope, the rays are transmitted to the eye applied at the ocular end of the cystoscope. Owing to the fact that a prism is employed as a mirror, we obtain an inverted image. This, at first, may lead to some confusion; but, after a little practice, it will be found that one grows sufficiently accustomed to this change to be able to disregard it entirely. To overcome the difficulty of dealing with the inverted image, the use of the straight-tube telescopic cystoscope, minus the prism, has been advocated by Brenner and others. All the instruments of the Brenner type, while giving us an image in its proper relative position, have the disadvantage that there are parts of the bladder wall which cannot be brought into the field of vision. The indirect cystoscopes made by the Wappler Company now have a correcting appliance in their telescopes by means of which the image is seen as it naturally exists, that is, not inverted.

The Observation, Irrigating, Catheterizing Indirect Cystoscope.—Nitze added an irrigating apparatus to his cystoscope, making an irrigating instru-

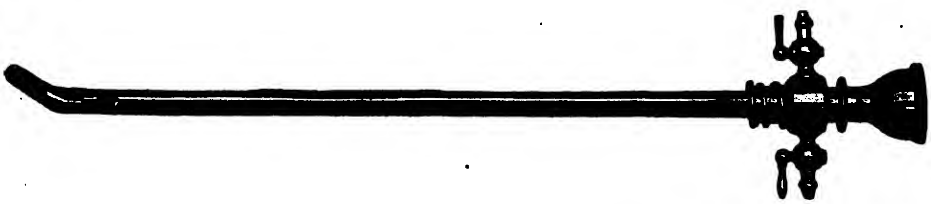


Fig. 198.—Nitze's Irrigating Cystoscope, Showing the Nozzles for the Entrance and E[x]
of the Solutions.

ment (Fig. 198). Later he made further improvements, enabling him to treat and operate on bladder lesions and crush stones and remove foreign bodies. He also added a channel to his instrument through which a catheter could be passed into a ureter. Nitze, then, advanced a step beyond Brenner, in that he had

combined (1) observation cystoscope, (2) irrigating cystoscope, (3) single-catheterizing cystoscope, (4) operating cystoscope and (5) photographing cystoscope.

Nitze Operating and Photographic Cystoscope (Fig. 199).—The cautery snare is used to cauterize the base of growths in the bladder.

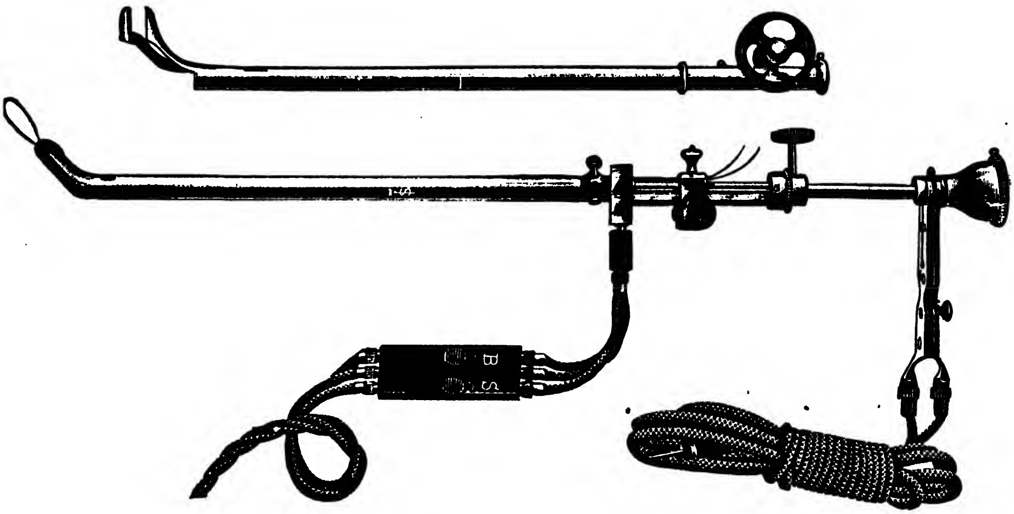


FIG. 199.—NITZE'S OPERATING CYSTOSCOPE, SHOWING THE SNARE AND LITHOTRITE.

The lithotrite can be used for crushing small stones, while the evacuator washes out the fragments.

The photographic cystoscope requires much care and rarely produces photographs which will repay one for the time expended upon them.

Mechanism for Influencing the Direction of the Ureteral Catheter.—The Nitze cystoscope was a better one for catheterizing the ureters, as it could not only show the ureters in women as well as the direct instrument, but in men it could turn its beak over the base of an enlarged prostate and catheterize the ureter when it could not be done with a direct instrument. It was, however, exceedingly difficult to introduce a catheter into the ureter by means of Nitze's indirect cystoscope. Casper modified Nitze's instrument and constructed a slot along the concave shaft of the instrument, which helped to give a turn or bend to the catheter, thus facilitating its entrance into the ureter.

Albarran modified Nitze's catheterizing instrument by constructing a lever upon the concave surface of the shaft at the point where the catheter comes out, which can change its direction by the turning of a screw on the side of the cystoscope. This lever in Albarran's instrument is a little tongue of metal which is controlled by the screw near the handle, by means of which the end of the catheter can be pushed away from the prism or lamp and straighten out at any angle to the cystoscope the operator desires. Albarran's instrument, in addition, had

an irrigating attachment somewhat similar in construction to that seen in the newer types of Nitze's catheterizing cystoscope (Fig. 200).

FIG. 200.—NITZE-ALBARRAN CATHETERIZING CYSTOSCOPE, SHOWING THE LEVER FOR MOVING THE ENDS OF THE CATHETERS TOWARD THE URETERAL OPENINGS.

The Air Direct-Observation and Single-Catheterizing Cystoscope.—At about the time that the Nitze-Albarran cystoscope was considered the highest development of the combined observation and catheterizing instruments, the catheterizing of the ureters was still considered a mysterious, sleight-of-hand trick, and was not believed possible by many practitioners, who were inclined to put in the fakir class anyone who professed to be able to do it. Indeed, so wonderful was it considered, that the announcement that a lecture on catheterization of the ureters was to be given with a demonstration of the same was sufficient to pack an amphitheater.

How strange it must have seemed to the unbelievers of the profession to see a direct cystoscope put upon the market (by an instrument company in Rochester, N. Y.), which was not only capable of showing the ureters in a bladder dilated with air, but by means of which the ureters could be catheterized even by the lay salesman who sold it! It seemed then that cystoscopy had been brought to such a simple form that any practitioner could examine the interior of the bladder and perform a ureteral catheterization. It was found, however, on trying the instrument, that such was not the case and that a knowledge of the subject on the part of the best physician or surgeon did not avail as much as practice in the hands of a lay agent of the company. Many of these so-called direct-air cystoscopes could be used by means of a water medium as well as by air. Since then air cystoscopes have been used in France, and much improved by Luys and Cathelin.

The *air cystoscope* consists of a tube which has in its upper wall a smaller passage for the conduction of a wire that connects with the electric lamp and on its lower or convex wall another tube for the introduction of the urethral catheter. The light from the lamp emerges through a glass window, in the convexity of the main tube near its end. The lamp, when burned out, is removable by unscrewing the tip and pulling it out. To facilitate the introduction of the cystoscope, an obturator is furnished, which closes the distal orifice and prevents scraping of the membrane against the edges of the opening. A glass-covered cap may be placed over the ocular end to enable the operator to distend the bladder forcibly with air, when that condition is not effected by posture. The inflation is made by a rubber bulb attached to a stop cock.

The instrument resembles somewhat the megalescope of Boisseau du Rochet (Fig. 201).

The Cold Lamp.—The use of cystoscopy by air dilatation was first made possible by the production of a diminutive incandescent lamp, practically heat-

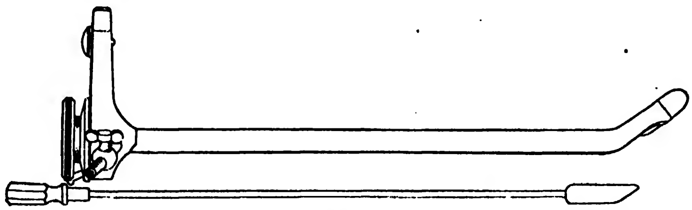


Fig. 201.—A Direct Air Cystoscope of American Make.

less, by E. C. Preston of Rochester. He first began to manufacture it for throwing light into the nostrils, by using it on a long holder for illuminating the mouth and throat, and also attached it to a tongue depressor. Later, working with Dr. Koch of Rochester, they applied it to urethroscopes and cystoscopes, calling it the Mignon lamp.

As soon as the cold lamps were introduced, I had them placed in all of my imported cystoscopes—the Nitze, Albarran, Leiter and Fenwick—and have been using them as cold-lamp cystoscopes since that time. The cold lamps do not give as powerful a light, however, as the hot lamps, and at times superficial ulcerations might be overlooked. The cold lamps have been very much improved since they were first introduced and are now much more powerful and durable.

It is claimed that it radiates so little heat that it may be held within a quarter inch of live tissues for an indefinite period without any discomfort, to say nothing of pain. It is really this property of the electric lamp that made the air instrument feasible. A hot lamp requires the protection of fluid before it can be safely introduced into the bladder. Thus, the use of fluid is eliminated, together with its several disadvantages, such as rapid clouding by inflowing pus or blood, etc.

From the brief description given, it is evident that the air instrument is extremely simple, which, I believe, is one of its chief advantages. Its freedom from complexity relieves it from many of the sources of difficulties encountered in the use of the older forms. Many of them have no lenses between the eye and the subject of investigation. Lenses must be perfect in order to be of any service whatever, and perfection in them is both expensive and difficult of attainment; also, after perfection has been attained, the usefulness of the instrument may be destroyed in an instant by their displacement in the slightest degree.

The Combined Observation and Double-Catheterizing Cystoscope.—The advance in cystoscopy next turned to perfecting the double-catheterization appa-

ratus which had been devised by Boisseau du Rochet some time before this. The catheterizing apparatus consisted of a double tube, or else a single tube divided in two parts by a partition. In either case, two ureteral catheters could be placed in the cystoscope at the same time. Such an arrangement for the carrying of two catheters was incorporated in both the direct and indirect instruments.

Direct-catheterizing cystoscopes through a water medium were brought out in this country by Ayres, Brown, Cabot, Kolisher, Schmidt, myself and others, while that of the indirect type was first brought out by Bierhoff. The addition of the double-catheter channel, however, did not interfere with the observation purpose of the instruments any more than when the single-catheterizing tube was used.

The *first direct-observation and double-catheterizing cystoscope of American make* was brought out by Brown of New York. It was manufactured by Wappler of the Wappler Electric Controller Company, of this city. The shaft

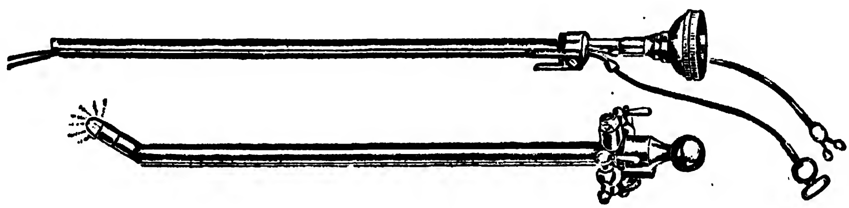


FIG. 202.—THE BROWN CYSTOSCOPE. Below is the shaft with its obturator, and above it is the direct telescope showing the catheters in their grooves.

of this instrument was constructed on the same plan as that of the direct-observation type and the light showed through a window in the convex side of the beak. The instrument, like that of the observation type, was introduced into the bladder with a mandrel in place. After the end of the instrument was in the bladder, the mandrel was withdrawn and the telescope carrying the catheter was introduced. It now has a double passage in order to carry two catheters (Fig. 202).

Indirect-Observation and Double-Catheterizing Cystoscope.—Bierhoff was the first in this country to construct a double-catheterizing cystoscope of the in-

FIG. 203.—BIERHOFF'S INDIRECT CATHETERIZING CYSTOSCOPE.

direct type. (*Med. News*, March 8, 1902.) The size of the instrument is 23 French. It is arranged for double-current irrigating.

It is a modification of the improved Nitze-Albarran catheterizing cystoscope and consists of a cystoscope upon which is the *movable* catheterizing portion.

(See Fig. 203.) The latter contains two separate tubes in which the catheters pass and which terminate at the outer end in two separate cannulæ capped by the usual screw caps. At the inner end they terminate in two small, movable tongue, finger or knee mechanisms, which are controlled and moved by the large screw, as in the single-catheterizing instrument. There are also two stopcocks to replace the screw caps upon the cannulæ, when the double-current irrigation is to be employed. The catheterizing portion, being movable, can be sterilized by boiling. The cystoscope itself must be sterilized by formalin vapor or by immersion in an antiseptic solution (Holstein solution).

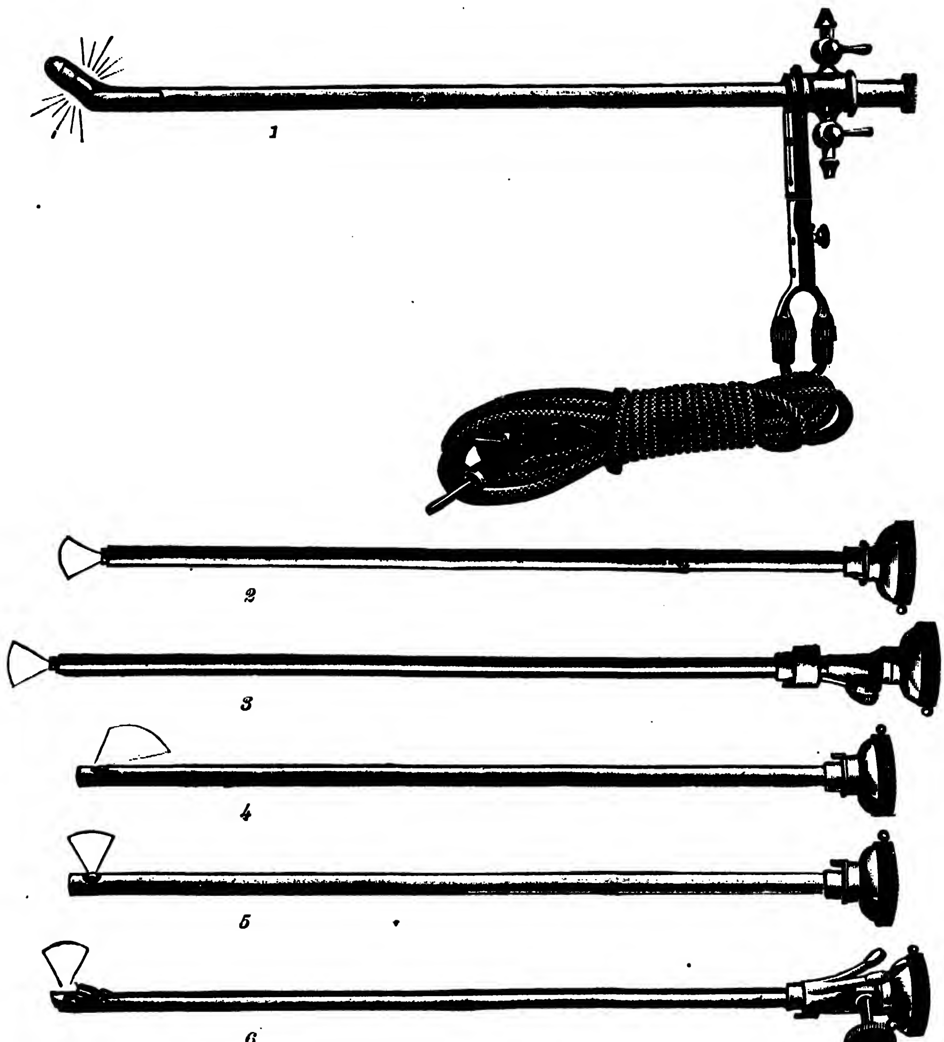


Fig. 204.—Bransford Lewis Cystoscope.

1. The shaft.
2. The direct observation part.
3. Direct catheterizing.
4. Retrograde vision.
5. Indirect observation.
6. Indirect catheterizing.

The first direct-observation and double-catheterizing air cystoscope in this country, was that of Bransford Lewis, made by one of the Rochester companies (Fig. 204). This was shortly afterwards made into a water cystoscope and is manufactured by Kny-Scheerer. It is a very complete instrument and is to-day probably the cystoscope that has more additional contrivances for bladder work than any other.

The Combined Direct and Indirect Teaching Cystoscope.—Five years ago I had a combined direct and indirect observation cystoscope constructed for examining the interior of the bladder. The need of such an instrument was shown to me by the difficulty that practitioners encounter in making a thorough and systematic examination of the bladder which is so important for bladder diagnosis; and for familiarizing oneself with the position and appearance of the mouths of the ureters before using the catheterizing cystoscope.

For a long time cystoscopy was not taken up in the United States, although it was quite extensively practiced in Europe. The two principal reasons for the neglect of this important step in diagnosis were the price of the imported instrument and the lack of teachers in cystoscopy, such as could be found in Berlin and Paris.

Eventually genito-urinary surgeons visited Berlin and Paris to acquire the knowledge and art in which they found they were lacking. Finally the instrument-makers and electricians in the United States, principally Wappler in New York and Preston in Rochester, through the suggestions of surgeons interested in cystoscopy, started to manufacture cystoscopes and they have placed very satisfactory and creditable instruments on the market.

At the time, however, when the American manufacturers began to introduce their instruments, the cystoscopists in Europe had passed through the period of observation cystoscopy and were interested in the catheterizing instruments. The result of this was that the catheterizing cystoscopes were principally brought out in this country, and were bought by practitioners without training in cystoscopy, who soon found themselves unfitted for the work. The instruments then became toys which they could not use, and when trials were made, it was generally for the purpose of endeavoring to pass catheters into the ureter, in which undertaking they were usually unsuccessful, in consequence of which most of them gave up cystoscopy as hopeless.

When I first started the cystoscopic room in my clinic nine years ago, I used the Leiter and Nitze indirect-observation instruments. The assistants following used a direct-observation and catheterizing instrument of American make, with the result that they found numerous cases of papillomas of the bladder. These proved to be from traumatism due to the rough manipulation of the telescopic end of the direct cystoscope. Accordingly, I made a rule that no one should do cystoscopic work until he had served a certain time as an assistant in the cystoscopic room, washing out the bladder and preparing the cases

for cystoscopy. After this no more vesical papillomas of this nature were seen.

I also found that, with the development of the direct-catheterizing cystoscope, the object of cystoscopy, that is, the examination of the interior of the bladder, was lost sight of, and the men working in cystoscopy simply looked for the ureters in order that they might catheterize them as a matter of practice.

Therefore I had this observation cystoscope made in order that the assistants might learn to examine the bladder before taking up the catheterization of the ureters and each man could spend six months on cystoscopy, three with the observation and three with the catheterizing instrument.

Description of the Cystoscope.—The teaching cystoscope is a combination of Nitze, Brenner and Boisseau du Rochet instruments, or, more properly speaking, of F. Tilden Brown, Bransford Lewis and William K. Otis, with modifications that have seemed to me practical, the principal one being the elimination of the obturator as an unnecessary attachment.

My cystoscope consists of four parts (Fig. 205): (1) A hollow shaft with a lamp in its beak; (2) a combined obturator and indirect-observation telescope;

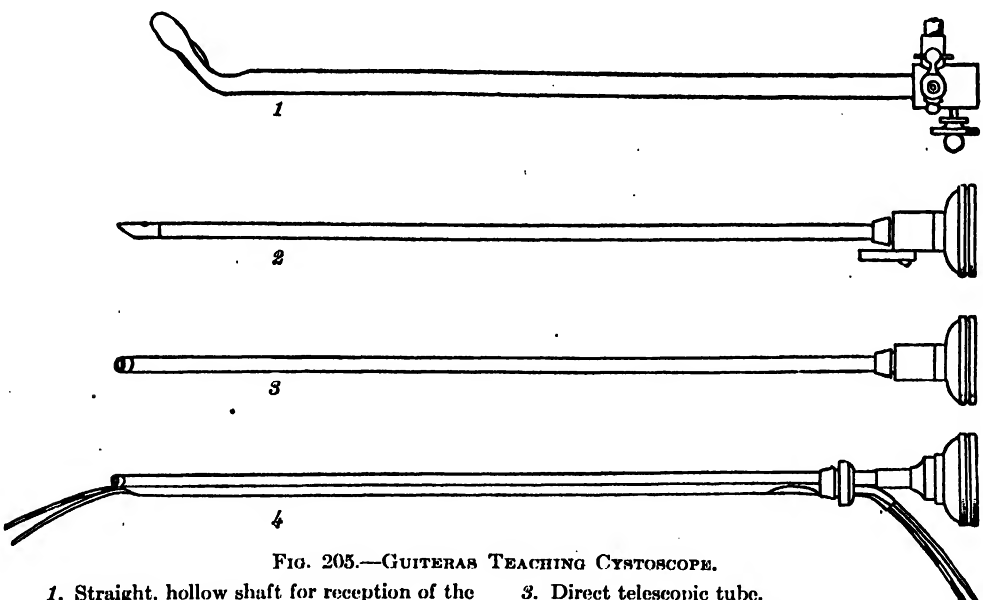


Fig. 205.—Guiteras Teaching Cystoscope.

1. Straight, hollow shaft for reception of the telescopic tube.
2. Indirect telescopic tube.
3. Direct telescopic tube.
4. Direct telescope with grooves for the catheters.

(3) a direct-observation telescope; and (4) a direct-observation telescope with catheterizing attachment.

To go into the separate parts more in detail: (1) The first is a straight tube with curved beak, in which there is an electric light that throws its rays both from the convexity and concavity. It has an open space on the straight part of

the shaft near the concavity, serving as a window through which one can look from the indirect visual part of the telescope that fits directly behind it.

(2) The second is a combined telescope and obturator with a visual apparatus, the window of which is about one third of an inch from its end. The end is solid, cut obliquely and of an angle that exactly fits in the distal extremity of the hollow tube which it fills, thus serving both as an obturator and for indirect examinations.

(3) The third is a telescope similar to those in all the direct Wappler cystoscopes for the direct examination of the bladder, which, when pushed through the hollow shaft, protrudes through the opening in its convexity.

(4) The catheterizing part closely resembles the direct telescopic portion, excepting that it has on its surface a fin with a groove on either side of it. These two grooves connect with the nozzles on the proximal end, through which the catheters are inserted. The catheters then pass along the grooves to the end of the instrument, being held in place by the inner wall of the hollow shaft as far as its distal end, from which point they are pushed out into the ureters when the instrument is in the bladder.

This instrument is very practical, as, with the indirect visual apparatus inserted, it answers the same purpose as a Nitze observation cystoscope. After the bladder has been thoroughly examined by the indirect method, the indirect apparatus is removed and the direct telescope of the instrument is introduced for the corresponding examination. The cystoscope stands for my teachings in cystoscopy during the last ten years: First, that a bladder should always be examined with the indirect cystoscope before the ureters are catheterized; second, the ureters are more easily catheterized by the direct cystoscope.

This instrument combines these two important principles. The straight, hollow shaft with a curved beak can hold either the indirect or direct telescopes (No. 1). When the indirect telescope is introduced, the solid beveled end of the telescope fills the opening in the end or convexity of the shaft and they enter in the same way as the former shafts did with the solid ends. At the same time, the mirror near the end of the indirect telescope fits into the window near the convexity, on the straight part of the shaft, in such a way that a most satisfactory indirect examination can be made.

Having thoroughly examined the bladder, the indirect telescope (No. 2) is withdrawn and the direct telescope (No. 4) containing the catheters is introduced into the shaft (No. 1) and its end protrudes from the opening in the end of the shaft. The ureters are then catheterized. No. 3, the direct-observation telescope, is only used in teaching the student to find the ureters.

There is an irrigating apparatus connected with the shaft (No. 1), into which the direct telescope has been introduced. The bladder can consequently be washed clean, examined thoroughly and the ureters catheterized without removing the outer part of the instrument.

The bladder can be washed out through the shaft of the instrument by allowing the solution to run through the opening in one of the posts when neither the direct nor indirect telescope is inserted, or through the same opening when the direct telescope is in place.

TECHNIQUE OF CYSTOSCOPY

The following practical part of this chapter has been the result of experience gained in twenty years of cystoscopy. The work was principally done in the Post-Graduate, Columbus and City hospitals. In my clinic at the Post-Graduate, we have done over 3,000 cystoscopies and ureteral catheterizations.

The following instruments and apparatus are required in cystoscopy:

(1) Cystoscope.
(2) Table with knee or leg rests.
(3) Battery; or, if street current is used, a controller.
(4) Soft-rubber and woven coudé catheters, Nos. 12 to 16 French scale.
(5) Piston syringe, holding six ounces; or a fountain syringe.
(6) Ultzmann syringe for injecting cocain.
(7) Antiseptics: Bichlorid solution, 1:2,000; silver solution, 1:4,000; boric-acid solution, 1:30.
(8) Cocain solution, 1:100.
(9) Glycerin as a lubricant.
(10) Test glass.
(11) Douche pan or Kelly pad to catch fluid.
(12) Slop jar at foot of table.

For sterilization of the cystoscope, catheters and above apparatus, see the chapter on Asepsis and Antisepsis. The cystoscope should never be boiled or placed in hot water. It may be sterilized in an emergency by placing it for fifteen minutes in a two-per-cent solution of formalin. This solution we prepare by adding two drachms of our stock office solution, called Holzien's solution, to one pint of water. (Holzien's solution is composed of formalin, sixty parts, and alcohol, forty parts.) Cystoscopes in the office are always kept sterilized and ready for use. After using them, they are cleaned on the outside with soap and water and then alcohol, wrapped in gauze and placed in Schering-Glatz formalin sterilizer for ten minutes and allowed to remain in the gauze until the next examination.

The catheters used for washing out the bladder should have been previously sterilized. This is done by boiling the rubber ones, while the woven ones are sterilized in the same manner as the cystoscopes. The author keeps the rubber catheters in a muslin bag, in which they have been boiled, while the woven catheters are kept wrapped in the gauze in which they have been sterilized.

Just prior to the examination, all instruments should be laid out on a sterile towel, where they will be within easy reach of the examiner. Before doing a cystoscopy, the instrument and the light should always be tested to see if they work properly and to determine how much light will be necessary; the optical part should be wiped with alcohol and dried with gauze. The urethra should also be examined to see if it will admit the cystoscope. Nothing is so exasperating as to prepare a patient for cystoscopy and find that the lamp is burned out or that the cystoscope cannot pass through the urethra.

It is well to have everything in readiness before the patient is brought into the room. The *table* generally used in this country is one which will admit of a certain position, that is, the body part at an angle of 135° with that part which supports the thighs. There should be supports on each side, either upright lithotomy bars or knee rests.

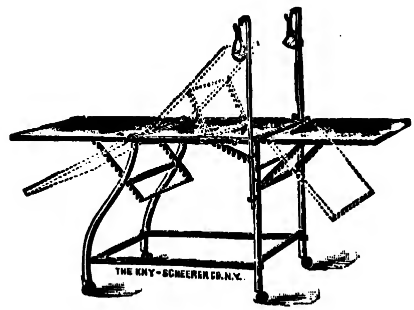


Fig. 206.—Portable Table Used for Cystoscopy in the Clinic and at Private Houses.

If cystoscopy is to be performed in a private house, it is advisable to send a portable metal table, which can be adjusted to the position already referred to; the apparatus referred to should also be sent.

The patient, if a male, is placed upon the table in a reclining position, with his head and shoulders slightly elevated and feet extended. The clothing is removed from the lower limbs, which are covered with clean towels, a sheet or flannel stockings. The external genitals are thoroughly washed with soap and water, followed by bichlorid solution 1 : 2,000 as for an ordinary surgical operation. The operator prepares his hands by scrubbing and immersing them in bichlorid solution.

In the case of a female patient, she is immediately placed in the gynecological position, with her feet on the sides of the upright lithotomy bars, or else her legs are supported by knee rests.

Washing the Bladder.—The first step is to determine the bladder capacity by the amount of urine voided, plus the amount of residual present; or else by measuring the entire amount of fluid that can be tolerated when injected into the empty bladder. A solution of boric acid, in the strength of one part of boric acid to thirty of water, is used for washing out the bladder. In cystoscopic work I usually have small packages consisting of half an ounce of boric acid wrapped in a piece of sterile gauze, and in making my solution I put one of these into a pint of hot water, or two into a quart. The solution is injected through the outer cylinder of the cystoscope from a fountain syringe, after removing the indirect telescope, or through a catheter from a six-ounce piston

syringe, until the patient's bladder begins to feel full. This marks the subjective capacity of the bladder in a given case, and the amount so injected should be noted for future reference. The more fluid a bladder holds, the more easily it can be examined.

When the bladder feels full, the fluid is allowed to escape into the test glass, its clearness or turbidity is noted and a fresh quantity is injected into the bladder until the viscus is filled. This is repeated until the boric-acid solution flows into the test glass perfectly clear. At times, this is not possible when there is much pus in the bladder; in such cases, we wash until we get as clear a washing as possible, and then hasten the examination for fear the bladder fluid will become clouded again before we see its interior. I have frequently washed out a bladder for an hour and a half without obtaining a fluid medium sufficiently clear for an examination. This usually occurs in cases of pus kidney or sacculated bladder.

The test glass is a small glass such as is used for mineral water, or else an ordinary tumbler.

Filling the Bladder.—When the washing of the bladder results in the discharge of a clear fluid through the catheter, the organ is filled with as much fluid as can be introduced without causing hematuria. The desired amount of distention for cystoscopy is 150 to 200 c.c. (5 to 6 oz.) of fluid in male cases, and 200 to 300 c.c. (6 to 10 oz.) in female.

Introducing the Cystoscope.—The instrument, having been well lubricated with glycerin, is then passed into the bladder, practically the same technique being used as in introducing metallic sounds. Very often the instrument glides into the urethra down to the cut-off muscle, where it meets resistance, due to a certain amount of spasm which takes place if the posterior urethra is involved and tender. The cystoscopist must not attempt to push the cystoscope through this muscle, for if he does it may be attended by a certain amount of hemorrhage which would blur the vision; therefore, he should hold the instrument against the muscle, exerting gentle pressure, and soon it will be felt to relax and the instrument will glide through into the posterior urethra and then through the sphincter into the bladder. Sometimes, however, it is not the cut-off which resists, but the vesical sphincter, in which case the same tactics are pursued and the cystoscope passes the rebellious sphincter and enters the viscus. A small amount of two-per-cent cocain, injected by means of an Ultzmann syringe or through a very fine catheter into the posterior urethra and the neck of the bladder just before the final filling, will prevent the spasm. This is usually caused by an inflammatory condition beyond the cut-off muscle or the bladder sphincter, which sensitive areas these muscles try to protect through their contraction.

Changing the Patient's Position.—The foot board of the table is then lowered to the full extent, and the patient, if a male, has his legs supported in

lithotomy uprights, or knee rests (Fig. 207), after which his buttocks are brought to within six inches of the edge of the table, the surgeon meanwhile keeping the cystoscope in place by a gentle grasp upon the handle of the in-

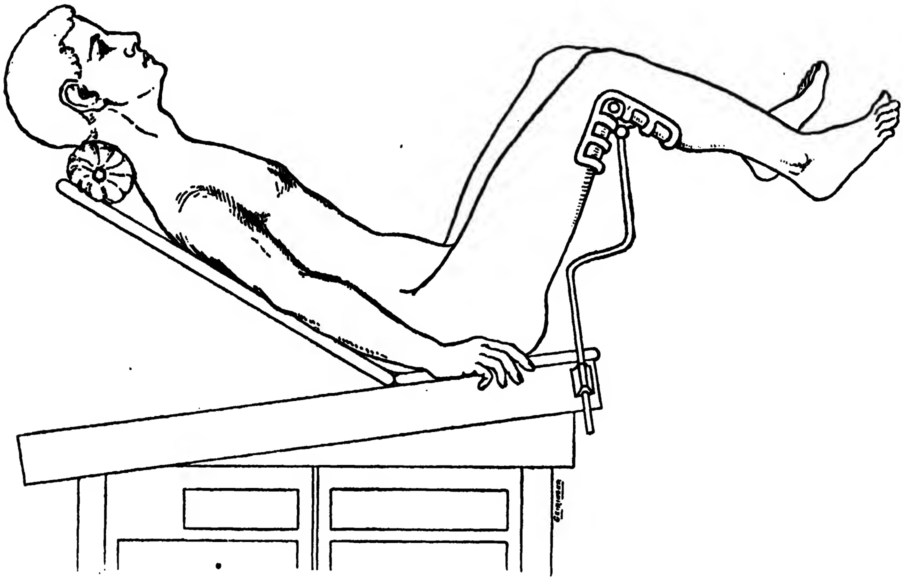


FIG. 207.—THE PATIENT'S LEGS SUPPORTED BY KNEE RESTS, AND THE SEAT PORTION OF THE TABLE SLIGHTLY ELEVATED, THE POSITION USUALLY EMPLOYED IN THE OFFICE. The table is the Allison model.

strument. In the case of a female patient, she is already in such a position from the first, and, therefore, does not require to have it changed. The patient's hips may be slightly elevated, as this helps the cystoscopist to examine the bladder more easily.

Should the bladder contents become too cloudy before the examination is completed, the cystoscope, in case it is a simple observation cystoscope, should be withdrawn, the bladder once more washed, filled with clear fluid and the instrument reintroduced.

The irrigating cystoscope has an arrangement for washing the bladder while the instrument is in place. In order to do this, there must be a small piece of rubber tubing on the nozzle of the irrigating opening, and water should be forced into this through a piston syringe. This not only cleanses the bladder wall, but also the window of the instrument and thus washes away any deposits of blood, mucus or pus, that may have collected there. The fluid escapes from a nozzle on the other side of the instrument. Thus a thorough lavage of the bladder can be made. In my own cystoscope, the lavage can be made through an irrigating apparatus by connecting the tube from a fountain syringe with the nozzle and allowing the solution to run into the bladder and out of the hol-

low shaft (Figs. 208, 209). The quickest way to cleanse the bladder is through the shaft of the instrument, as a larger quantity of solution can quickly run in and out again.

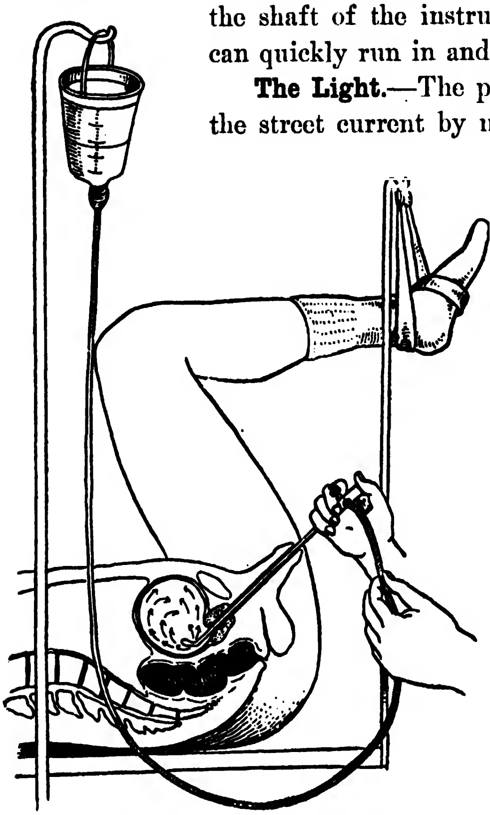


FIG. 208.—WASHING OUT THE BLADDER. The water is running in from the fountain syringe through a tube attached to the irrigating nozzle of the instrument; the thumb is held over the end of the hollow shaft. The force of the fluid can be changed by raising or lowering the irrigating jar.

The Light.—The power for the light is taken either from the street current by means of a Wappler electric controller, or else from a storage battery on the left side of the patient. One end of the cable is then connected with the cystoscope and the other with the electric controller or the storage battery, after which the operator turns on the current by means of a switch or screw in the handle of the cystoscope. And here the technique differs according to whether a direct or indirect instrument is being used.

If the instrument is indirect, as in the observation part of my own cystoscope, turning on the current is sufficient to allow the cystoscopist to examine the bladder; whereas, in direct cystoscopes of American make, it is necessary to withdraw the obturator, place the thumb quickly over the opening of the shaft of the instrument to prevent the escape of the fluid and then intro-

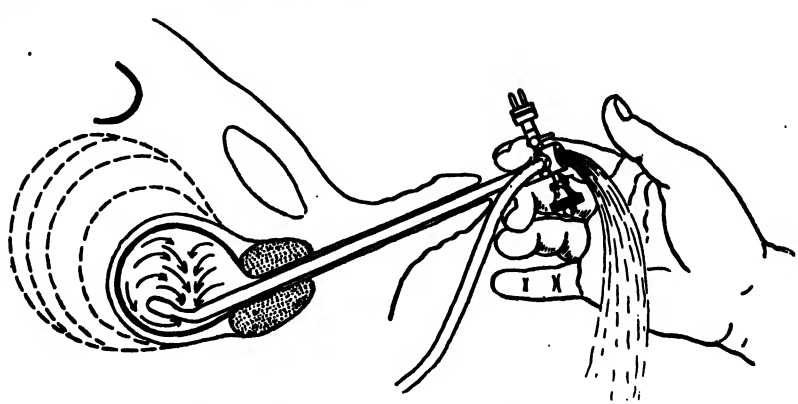


FIG. 209.—WASHING OUT THE BLADDER. The bladder has been dilated to its point of tolerance (see dotted lines), the thumb has been removed from the end of the shaft and the fluid rushes out through its lumen, the bladder quickly emptying.

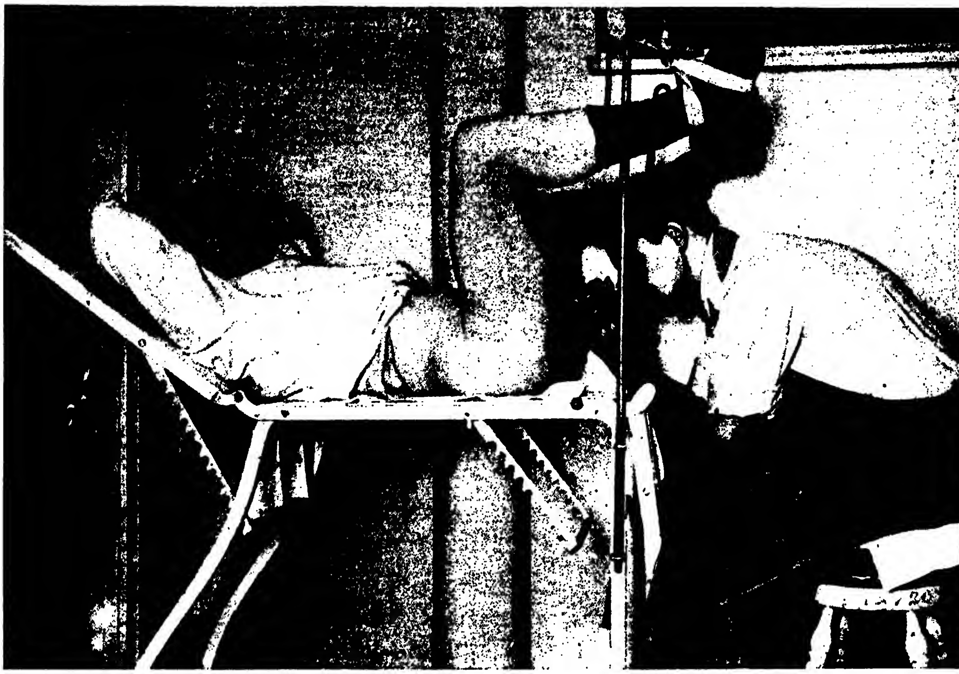


FIG. 210.—LOOKING INTO THE BLADDER.
The patient's feet are in lithotomy upright, the position usually used in the clinic.

FIG. 211.—AIR CYSTOSCOPE. Patient in partial Trendelenburg position. Bladder being inflated with air from tank on the table. (From Luys.)

duce the telescope before the interior of the bladder can be examined by the cystoscopist.

In either case, after the instrument has been introduced and everything is in readiness for examination and the cable connection is made, the examiner sits between the legs of the patient and turns on the power until the light is sufficiently bright for him to see plainly the interior of the bladder, before proceeding to examine it (Fig. 210). The storage battery, freshly recharged at regular intervals, is generally used for outside work in private houses and in the office or in hospitals, unless electric illumination is present, in which case a controller is preferable.

The position of the patient with air cystoscopy is different as, in this case, the patient is in a partial Trendelenburg position which allows the bladder to balloon out to better advantage and the urine coming from the ureter to gravitate toward the apex of the bladder and away from the instrument (Fig. 211).

DIFFICULTIES IN CYSTOSCOPY

Stricture of the Urethra.—The first difficulty encountered in cystoscopy is organic stricture of the urethra. Very few cystoscopes that give a good view of the bladder are less than No. 24 of the French scale in size. Therefore, the urethra should be at least 25 French in caliber, in order to allow free admission of the cystoscope without causing traumatism or hemorrhage. If the meatus is smaller than this number, it should be cut up to 28 or 30 French and should be treated as any other case of meatotomy for a few days, until it has healed to a larger size, sufficient to admit the instrument easily.

If there are strictures along the canal, they should be dilated, if soft and dilatable; if not, they should be cut to a sufficient size to admit the instrument before cystoscopy is performed.

Spasmodic strictures are also common, but they usually yield to instillations of a two-per-cent solution of cocain, given through a small catheter, or by means of an Ultzmann syringe. In case, however, that local cocain anesthesia is not sufficient, a general anesthetic should be administered, preferably nitrous-oxid gas alone or followed by ether.

An enlarged prostate that bleeds easily should be treated by a deep urethral instillation composed of equal parts of a two-per-cent solution of cocain and a 1:1,000 solution of adrenalin.

Pelvic exudates, uterine displacement and pelvic tumors, of sufficient size to interfere with the function of the bladder and to make cystoscopy difficult, are of enough importance to call for a vaginal operation in the first instance and an abdominal operation for the other two conditions.

Small, Intolerant and Sensitive Bladders.—Sometimes a few irrigations of the bladder will dilate it sufficiently to allow of a satisfactory cystoscopy, for

which 150 to 200 c.c. (5 to 6 oz.) is usually necessary. Examinations can, however, be made with two ounces of fluid in the bladder, and I have made them with but one ounce and a half, by means of an indirect instrument. In case a bladder is very sensitive, cocain or a general anesthetic should be used, as many bladders that will hold but from one to two ounces under other circumstances will, when anesthetized locally or generally, retain four ounces or more. Twenty grains of antipyrin and ten minims of laudanum in an ounce of water, injected into the rectum forty-five minutes before cystoscopy, will often relieve the patient sufficiently to permit a cystoscopic examination.

If the bladder is found intolerant and will not hold enough fluid, it should be emptied and half an ounce of a one-per-cent solution of cocain, or a two-per-cent solution of eucain, should be injected into the bladder through a catheter. Chismore, of San Francisco, in doing lithotomy in old men, used to inject two or three ounces of a three-per-cent solution of cocain into the bladder as a matter of routine, with no ill effects. Surgeons differ so much as to the strength of cocain used, that it is really a matter of individual experience. In the ordinary case, ten one-half-grain cocain tablets in two ounces of water, making a one-half-per-cent solution, is sufficiently strong for cystoscopic use. In cases of severe tubercular cystitis, a solution of the maximum strength cannot be relied on.

If cocain does not produce sufficient anesthesia, nitrous-oxid gas should be used during the introduction of the instrument; and if anesthesia has to be continued, ether should be administered.

Distention Hematuria.—Under ether, patients are supposed to hold more fluid in the bladder than when examined without anesthetics. If, under anesthesia, the bladder holds two ounces and you try to insert three for cystoscopy, you may have a pinkish discoloration of the fluid, due to the bladder wall being stretched and some capillary leakage resulting, or else bleeding from ulcerations, tumors or erosions. Such bladders can often be dilated, under anesthetics, better by means of the fountain syringe than by the piston variety. In this way, after a quarter of an hour of washing, during which time the hematuria may increase somewhat, perhaps five ounces can be introduced into the bladder. In these cases, the time that it takes for this amount of fluid to enter should be noted, and at the next filling a certain number of seconds under this time should be allowed the fluid to run in, to see if hematuria is caused. If hematuria is caused, then, the next time the bladder is filled, allow still less time for its filling; and so on until a point is reached where, in a certain time, the amount of water entering the bladder is not sufficient to cause a pink discoloration of the fluid. On the following injection of the bladder, if five seconds less are allowed, you will be sure to have a clear fluid for cystoscopy.

To make this clear, I will cite one or two cases. A patient with a cystitis dependent upon a hypertrophied prostate had a maximum bladder capacity of two ounces of urine. Under an anesthetic, his bladder held three ounces. The

three ounces ran in through the catheter in forty-five seconds. The next time, fluid was allowed to run in for one minute; four ounces were then introduced, which in escaping was found to be tinged with blood, being slightly pink in color. At the next filling of the bladder, a minute and a quarter was allowed and five ounces entered. The escaping fluid was then of a more reddish color. The next time it was allowed to run in for about a minute and a half, and six ounces entered. This on escaping was no more bloody than when the five ounces had been injected. The next time four ounces were put in in one minute and the fluid was clear. Five ounces were again put in, which showed on escaping a pinkish tinge, but not as marked as before. It was then felt that a little under four ounces would be the sure capacity of the bladder for cystoscopy without hematuria while under an anesthetic. This was accordingly carried out by allowing the fluid to run in for fifty-five seconds.

Another patient with tuberculosis of the bladder could hold but an ounce and a half of fluid when his bladder was washed out. Under an anesthetic two ounces entered in half a minute, producing no hematuria. Three ounces entered in forty-five seconds, producing hematuria. On introducing two ounces again, there was no hematuria. Several trials were made with three ounces both through fountain and piston syringe, and each produced hematuria. It was found that two and one half ounces could be put in the bladder in thirty-eight seconds without making the urine bloody. The cystoscopic examination was then made with this amount in the bladder. It must always be remembered that a very sensitive bladder, particularly in tuberculosis, will not dilate to its full capacity, even under general anesthesia, unless it is pushed to a point at which it is dangerous to life. Ether is the best general anesthetic to use.

NORMAL AND PATHOLOGICAL FINDINGS WITH THE CYSTOSCOPE

After the cystoscope has been introduced and the light has been turned on, it is always advisable to pursue a certain routine in the order of examination, so that one may not miss any part of the bladder in the survey and yet may perform the examination with as few movements of the instrument as possible.

We will now speak of the *indirect cystoscopes* used for observation which are the best for diagnostic purposes. As the field of the cystoscope is limited, we must form a picture of the entire interior of the bladder by means of a series of partial pictures which should so follow each other as the instrument moves that we gain a very accurate knowledge of the entire organ. The rules that Nitze gave for this purpose may be set down here for reference, although each observer will necessarily vary his method somewhat, according to his own practical experience.

Nitze advised that the anterior and upper portions of the bladder be inspected first and the fundus and trigone last. After the cystoscope has been in-

troduced, with the mirror pointing upward and the instrument parallel with the table, its beak is turned at an angle of 22.5° toward the right side of the patient and the instrument is now passed slowly backward until the beak touches the posterior wall. The field of the cystoscope thus sweeps over a section of the anterior and upper vault of the bladder, and covers part of the posterior wall. The strip of the illuminated bladder corresponds in width to the angle of the prism which defines the width of the field. As soon as the beak touches the posterior wall, it is turned still farther to the right (i. e., at an angle of 45° from the median line), and is swept forward, illuminating a strip parallel to the first, but lying to the right of the latter, sweeping the beak from behind forward and thus covering the right lateral portion of the bladder. Next the left half of the bladder is inspected. This is done by placing the instrument again in the median line with the beak at the internal opening and turning it 22.5° to the patient's left, sweeping it slowly from before backward in this position until it touches the posterior wall; then turning it to 45°, i. e., still more to the patient's left, and sweeping it from behind forward, thus covering the two zones lying to

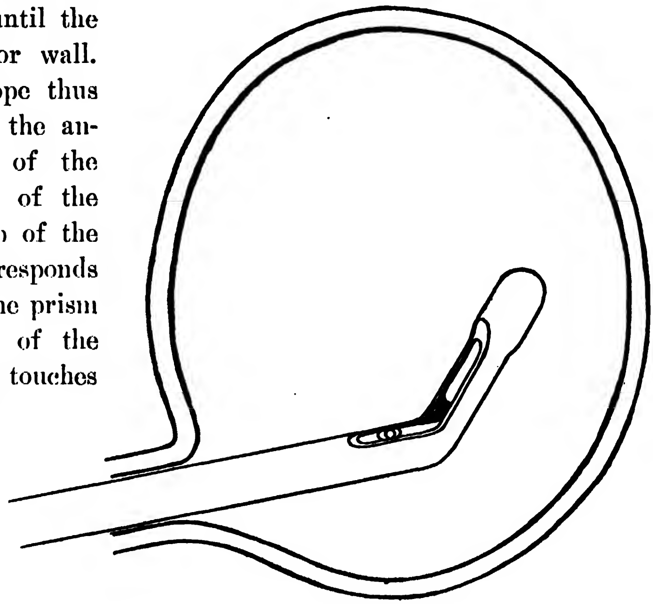


Fig. 212.—The Cystoscope Introduced into the Bladder.

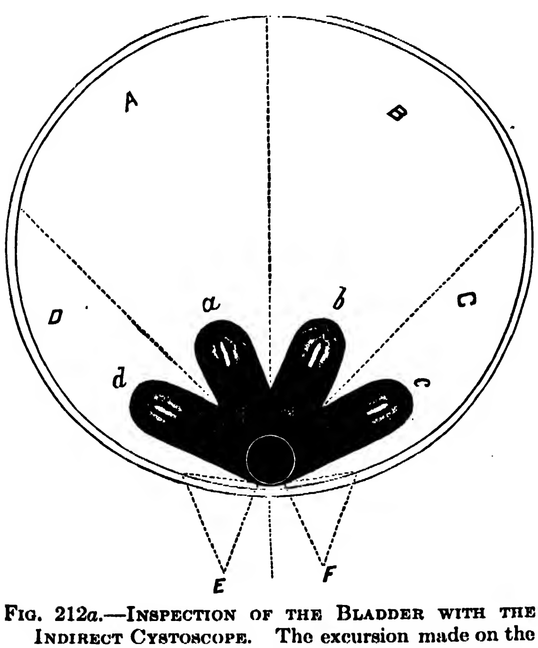


Fig. 212*a*.—Inspection of the Bladder with the Indirect Cystoscope. The excursion made on the right side of the bladder at an angle of 22.5° from the median line of the bladder, *aA*, and the excursion made at an angle of 45°, *Dd*. *bB* and *Cc* show similar excursions on the left side of the bladder. The cystoscope turned down in a similar position would easily show the trigone. (From Morrow, after Nitze.)

the left of the median line. With these four motions, two to the left and two to the right, practically the entire upper and lateral portions of the bladder are inspected (Fig. 212*a*).

There remains to be seen now the fundus and the neighborhood of the internal meatus. For this purpose the instrument is turned so that the beak points directly downward and is swept from side to side from behind forward, or from before backward, until every portion of the posterior wall of the bladder and the trigone has been covered. It is needless to say that all these manipulations must be gentle to avoid injuring the bladder wall. Burning the bladder would not be liable to occur with the cold lamp now generally used in this country, although it was common when the hot lamp was in use.

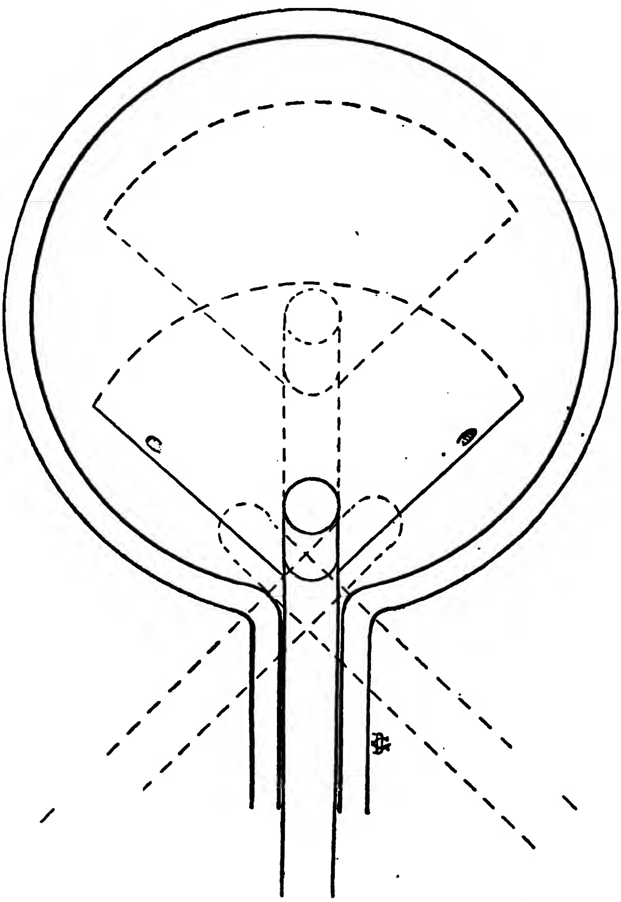


FIG. 212*b*.—INSPECTION OF THE BLADDER WITH THE DIRECT CYSTOSCOPE. The beak of the direct cystoscope is moved from right to left and *vice versa* in examining the floor and roof of the bladder, and from above downward in examining its sides.

The *direct cystoscope* is not so good for observation purposes. It is introduced with its obturator, which is then withdrawn and the direct telescope inserted. It is then pushed well back into the bladder and its beak is tilted up and swept from side to side, in this way showing some of the roof of the bladder with the adjoining part of the anterior wall; the lateral and posterior walls are then examined and the instrument is drawn forward until the interureteral band and the trigone are seen. This applies to direct-air or water cystoscopes, while another telescope, made by Wappler, with an opening in the side near the end, allows us to look back at an acute angle at the neck of the bladder and the prostatic base.

Normal Cystoscopic Pictures.—It is necessary for the practitioner to be familiar with the appearance of the normal bladder before he can understand

the conditions seen in a pathological organ. The interior of the bladder as illuminated by the cystoscope has a pale-yellow, orange or a pink tinge, depending for its exact color upon the lamp and prism used. A number of branching blood vessels are seen outlined upon it in darker red, which in healthy bladders are clear-cut and finely drawn. The upper hemisphere of the healthy bladder wall is smooth, but as the cystoscope is drawn over the posterior wall toward the neck of the bladder at its base, a thickened, slightly redder portion is brought into view, triangular in shape and tapering toward the vesical neck, where it ends in a dark-red color. This triangular space, with sides an inch and a quarter to an inch and a half long, is called the trigone. Its apex corresponds to the internal meatus, and its base to the interureteral band. The apex is on the base of the prostate in men, which is a dull red, or crimson, color. The female bladder differs from the male principally in not showing so much thickening about the internal meatus, nor such a well-marked trigone. The base of the trigone sweeps from one ureteral opening to the other and disappears in the wall of the bladder beyond these openings, where the color changes to an orange shade. On either side of the trigone is the paratrigonal fossa.

The Finding of the Ureteral Orifices.—The next step is the most important of the whole procedure, namely, the finding of the ureteral mouths. With the direct instrument, it is more difficult to inspect the bladder walls and consequently the position of the instrument must be changed considerably to accomplish this. The instrument in the bladder, with the direct telescope inserted, should be pushed back slowly, in the median line, illuminating the trigone until the interureteral fold is brought into view. The end of the cystoscope is then turned from the right to the left, following the interureteral band, until an angle from 30° to 40° from the perpendicular is reached, when the ureteral orifice will usually be brought into view. This is the theoretical procedure, but practically the exact modus operandi must be varied to a marked extent, according to the condition of the ureters, which varies normally to a considerable degree according to various peculiarities of the bladder of the individual examined.

The Appearance of the Ureteral Orifices.—The ureteral openings are at the two posterior angles of the trigone and present in most bladders the shape of a slightly oblique, dark-red slit, or a more rounded depression, and are situated upon a more or less marked papilla or prominence. With the indirect cystoscope and the patient in the cystoscopic position, if the beak is turned downward, the part of the bladder before us will be the base, the interureteral band and the ureters.

Difficulty in finding the ureter in a healthy bladder depends usually on an insufficient amount of fluid and the consequent folding in of the mucous membrane in places. The introduction of an additional amount of water through the irrigating apparatus, by dilating the entire wall, will stretch out these folds

and bring the ureters into view. This is best accomplished as follows: The irrigating nozzle of the cystoscope is connected with the tube of a fountain syringe, or the tip of a large piston syringe is inserted into a small piece of tubing attached to the irrigating nozzle, and the fluid slowly injected, while at the same time the base of the trigone is carefully watched. This portion of the bladder is sometimes out of position; in men, usually due to prostatic involvement, and in women, due to cystocele. In such cases, the finger, a rectal bag or a vaginal depressor inserted into the rectum will serve to push it to a better position.

Having found the ureters, it is well to examine them carefully, not only for the sake of learning their shape and locality, but also to note any abnormalities connected with them or the urine they emit.

The ureteral mouths are sometimes so dilated as to resemble diverticulæ, and I have at times been able in this condition, after a perineal urethrotomy, to insert the tip of my forefinger into the mouth of each ureter.

If a ureteral mouth is prolapsed, it reminds us that there may be some inflammation of it, or, more probable, that a calculus is present in the ureter near the opening into the bladder, not perhaps of the correct shape to absolutely occlude the ureter, but sufficient to give rise to ureteral strain and a consequent protrusion of its walls. Sometimes a stone can be seen protruding into the bladder, as a dark spot in a gaping ureter.

If the ureteral openings be watched for a time every thirty to sixty seconds, the slit may be seen to dilate suddenly, to take on a transparent pink-orange hue and a whirl of fluid of an oily appearance is seen streaming from it as the result of the expulsion of the urine from the ureters. These spurts are not synchronous.

In disease, the ureteral opening is often markedly altered and blood and pus may be seen coming from it. Blood coming from the ureters is almost always renal, although it may be ureteral. It usually comes down mixed with the urine and is often squirted out like a thin stream of red ink, although clots, of a wormlike appearance, may descend. Pus comes down in flakes and is carried away in the swirl and then seen to scatter and fall in the bladder, or else a flake may catch in the ureteral mouth and be thrown out with the next swirl; or it may come down from a ureter as a thick mass and remain hanging in the bladder at the ureteral mouth, or mixed with urine giving it a milklike color, or as a mealy mixture which is shot out in a urinary swirl.

Pathological Findings in the Bladder.—Cystoscopy tells us whether the ureteral orifices are both present, their location, shape and condition, whether they are both secreting urine normally, and whether this urine is clear, purulent or bloody. It also enables us to determine whether the sphincteral margin is normal or the seat of disease, such as inflammation, ulceration, papillomatous formation, etc.; whether the trigone is normal or the seat of inflammations or new growths; or whether foreign bodies or calculi, which occur in a majority

of cases in this region, are present. It shows us the presence and probable character of new growths; the presence and position of foreign bodies and calculi; the presence of prostatic hypertrophy, of cystocele, the condition of the wall of the bladder and whether it is the seat of trabecular bands or the scarlike contractions of pericystitis; whether it is normal or the seat of inflammations, points of hemorrhage, ulcerations, nodules, new growths, vesicles or diverticulæ; whether the cavity of the bladder is encroached upon by other organs, as an enlarged or displaced uterus or by pelvic tumor-masses or exudates.

Trabeculæ, Bands and Pouches.—When the bladder is subjected for a long time to an increased strain, the muscular wall may become more or less hypertrophied, the result being that muscular bands develop in certain parts of the bladder, while other muscular fibers remain unchanged. When we look into such a bladder, we notice prominent bands or trabeculæ crisscrossing in various directions and forming an irregular network. As the hypertrophy goes on, the bands become more and more markedly developed, resembling the intertwining of the roots of trees in the woods or swamps, and the spaces between them become dark depressions. When large enough, these depressions are called diverticulæ. With an increase of pressure and with an atonic condition of the depressed portions, the latter become veritable pouches, which sometimes have such small mouths that their interior cannot be inspected. In fact, in many bladders removed at autopsy the pouches have such small mouths that they look like distended ureteral orifices.

Trabeculation is easily recognized even by the beginner and may be interpreted as a sign of hypertrophy of the walls due to some condition which interferes with the emptying of the bladder. The conditions may be a small meatus, a stricture or enlarged prostate in men, and displacement of the bladder, adhesions or pressure on the outside of the bladder in women.

Inflammations of the Bladder.—It is difficult to cystoscope a patient with an acute cystitis on account of the very sensitive condition of the bladder. Inflammation is most frequently about the vesical neck, although it may extend throughout the viscus. Less frequently there is a generalized reddening and intense congestion of the entire bladder. The characteristic changes of an acute inflammation consist in the presence of reddened areas with many enlarged blood vessels, with the presence of pus and mucus—both upon the walls and in the fluid which becomes rapidly turbid—and at times blood oozing from the walls which quickly renders the field obscure. When we make a closer examination of the mucosa in such cases, small erosions, which have a dull surface instead of the normal shiny lining of the wall, and localized hemorrhagic areas, which appear as dark-red patches, may be noted.

In chronic cystitis, the bladder is usually pale in its interior, except over the trigone, where it is generally thickened and reddened. Reddened patches may also be noted in other portions of the wall, however. In cases of long standing,

with hypertrophy of the walls, there are also trabeculæ and pouches. Accumulations of pus may be noted adhering to the walls, or hanging or waving in the fluid in the form of shreds. The blood vessels are turgid in places and circumscribed ulcerating areas may also be seen in this condition.

In the early stages of chronic cystitis, there is no perceptible change in the volume of the bladder, but later on there may be hypertrophy, or an interstitial inflammatory process with a contraction of the viscus; while in the advanced stage of chronic obstructive cystitis, there may be a dilatation of the organ due to the retention of urine. When this takes place, the mouths of the ureters will appear to be enlarged and distorted.

Simple Ulcers of the Bladder.—Simple ulcers may be either single or multiple. If single, they are usually large and accompanied by thickened and elevated edges and irregular base which may be covered by a collection of phosphate-of-lime salts or an accumulation of pus. Multiple ulcers are usually smaller and less marked. They are sometimes mistaken for epithelioma, especially when they are large and have a coarse, granular base covered with pus. They are generally due to traumatism and heal, leaving scar tissue.

Tuberculosis of the Bladder.—Tuberculosis of the bladder is one of the most frequent pathological conditions. In its early stages, all that can be seen are the minute lesions, white, yellow or gray, surrounded by a pink areola. These are seen scattered about the bladder, often in clusters. Later they break down as tubercular ulcers which are of different varieties. There may be a cluster of small ulcers resembling a cold sore, but more infiltrated, usually seen about the mouth of a ureter; or a local thickening with fine ulcerations on its surface; or a superficial ulcer resembling an erosion with the epithelia removed, and a pink, pulpy surface with the edges but slightly marked and with almost no infiltration. In other cases the bladder, especially the trigone, may be covered with small ulcers, the wall intensely inflamed, oozing blood and contracted: this is spoken of as hemorrhagic cystitis. In this last class of cases, which are tubercular, it is difficult to obtain a good view of the bladder, even under an anesthetic.

When ulcers are seen around the ureteral mouths, we must suspect a tubercular renal affection on that side, especially when such ulcers have some surrounding hyperemia and a base so uneven as to make it difficult to know which of its various recesses is the opening into the ureter. In advanced cases of tuberculosis of the bladder, the organ is so contracted and sensitive that cystoscopy cannot be satisfactorily performed.

Stone in the Bladder.—Stone in the bladder can usually be recognized quite readily with the cystoscope. The appearance of a stone in the bladder, next to a tumor, is the most beautiful sight in cystoscopy. The detection and recognition of stones, however, is not so simple as might be supposed. The position of stones varies quite markedly with the position of the patient. When

the patient is standing, the stone tends to fall down into the depression at the neck of the bladder. When the patient is lying down, the stone tends to fall back upon the posterior wall of the bladder. When reclining, with the body elevated at a moderate angle (145° or less), the stone tends to rest on the trigone. It is in these two latter positions that the calculus is best seen through cystoscopy.

The appearance of stones through the cystoscope is somewhat deceptive, as they look much larger than they really are, especially if the cystoscope is brought close to them. The shape of the stones cannot always be accurately determined with the cystoscope and some stones which seem fairly well rounded, appear like lozenges when they are removed.

One of the difficulties often mentioned in the diagnosis of stones, is the tendency which they have to lodge in pockets. This is not so common as was formerly believed before the cystoscope was in use. The principal pocket for stones is in a posterior prostatic pouch in men, and in a cystocele pouch in women. Cystoscopy can do more to show the presence of pocketed stones than the stone-searcher or any other method save exploratory incision. A cystoscopic examination should be made in every case in which stone is suspected, and, in fact, in every case of chronic cystitis before we exclude the presence of stone. Vesical calculi are sometimes not detected by cystoscopy, and I have seen well-known genito-urinary surgeons fail to see them when situated in the postprostatic pouch.

Tumors of the Bladder.—These can be properly diagnosticated only with the cystoscope. They vary greatly in size from that of a split pea to that of an orange and are either infiltrating, sessile or pedunculated, the sessile form being more common. If malignant, the surface may appear granular and red or whitish and covered with pus or salts like ulcers of the bladder. Sessile growths sometimes appear like a luminous cone in the crater of a volcano, while at other times they have a cauliflower appearance or a warty surface. Pedunculated tumors are usually more vascular, and the growth is not so dense. The small, pedunculated growths have numerous tendrils that wave about as they are struck by columns of urine shot from the ureters.

Tumors of the bladder frequently bleed so that it is impossible to use the cystoscope satisfactorily. In such cases, it is best to wash out first with hot boric acid and then to use a solution of adrenalin. This often stops the hemorrhage, but sometimes defeats the purpose of the examination, as the adrenalin shrivels up the tumors to such a degree that, when small, they cannot be seen. In one case of most persistent hemorrhage, no tumor could be found upon cystoscopic examination; I saw simply a dark area on the anterior wall of the bladder which could be barely made out on account of the rapid discoloration of the fluid. The tumor, which was afterwards discovered at the operation, was no larger than a very small French pea and was directly in the

line of the incision so that it showed only when the retractors were taken away.

The posterior wall of a hypertrophied prostate at times simulates a tumor, in that it resembles a new growth with a granular surface which projects into the bladder; at other times a bladder tumor develops on the base of the enlarged prostate, showing itself as a papilloma.

Malignant tumors, especially those situated about the trigone, which is the favorite location, are often red and indurated, their color sometimes resembling the coral of a boiled lobster. These tumors usually have an irregular surface which may be granular or lenticulo-papular.

Rugæ sometimes resemble papilloma, especially if they have suffered from traumatism. When we first began to use the direct cystoscope in the clinic, numerous papilloma were diagnosticated, but these usually disappeared with rest and bladder washing. Multiple sessile villous tumors of the bladder are sometimes seen, but slightly elevated and covering a large part of the bladder area.

In prostatic hypertrophy, the base of the gland often projects into the bladder. A dark space may be seen behind it, which is a favorite seat for calculi. These can usually be seen with the cystoscope and resemble eggs in a nest, although they are occasionally overlooked.

Edema Bullosum Vesicæ.—Of the forms of edema which affect the human bladder, that which Kolischer describes as "edema bullosum" is perhaps the most characteristic, and certainly the most interesting. Circumscribed areas of the vesical mucous membrane appear to be covered by vesicles varying in size from a small seed to a pea, often closely packed together, between which white, floating particles are seen adherent at one end to the bladder wall, the probable remains of ruptured vesicles. They are situated near some inflammatory tissue pressing against the bladder wall, as carcinoma of uterus, tumors of the prostate, pelvic tumors and in connection with cystoscopic burns, pyosalpinx, parametritic exudates and abscesses.

Intravesical Evidence of Perivesical Processes in the Female.—In women with bladder symptoms, a condition resembling trabeculated bladder is often seen. Bierhoff noticed that the changes were confined to limited portions of the bladder wall and occurred in people without obstruction or difficulty in urination, but who were suffering, or had formerly suffered, from parametritis or similar trouble. He examined 443 cases. In 214, there was a history of parametritis or perimetritis. In 264, there were symptoms referring to the urinary organs present. In 136, pericystitic strands were seen.

In cases of perivesical inflammation, the cystoscopic picture varies according to whether it has extended to and involved the bladder wall, or only the adjacent tissues. If the process is recent, the exudate encroaches to a greater or less extent upon the bladder, the distensibility of which is, to a corresponding

degree, impaired. If the exudate is unilateral, the excursions of the cystoscope are limited on the affected side, while normally free on the unaffected one. Similarly, if it occupies Douglas's cul-de-sac, the uterus tends to be somewhat displaced forward and the excursions are limited toward the posterior wall of the bladder. In all these cases, if any amount of exudation is marked, the bladder wall will be seen to bulge inward over the site of the exudate. When an inflammatory process in the tissues adjacent to the bladder extends to and involves the wall of this viscus, as in cases of salpingitis and perisalpingitis, "edema bullosum" is often present.

When the process is an old one and the exudate has gone on to organization, the cystoscopic picture is an entirely different one. In the same way that displacements of the uterus and adnexa may be caused by the traction of the fibrous strands, resulting from the contraction and organization of an inflammatory exudate, we may have the bladder affected by these strands pulling upon parts of its wall. The most characteristic appearance, however, in these cases, is the presence, over *parts* of the bladder wall, of sharp, scarlike formations, which rise, to a greater or less extent, above the surrounding wall, have a yellowish-white color and tend to fimbriate at the ends. The parts usually affected are the lower lateral and the upper posterior, and the postero-lateral portions of the bladder.

The pericystitic strands are limited to certain circumscribed portions of the bladder wall, and are less marked above the surface than regular trabeculæ. They tend to have fimbriated extremities and are of sharp contour. These conditions of the female bladder, described by Bierhoff, were frequently noticed by me in my gynecological ward at the City Hospital, and the operations confirmed the cystoscopic and gynecological examination made. His admirable description of these conditions from the view point of a cystoscopist, cleared for me many an uncertainty which I did not understand prior to reading his work.

CATHETERIZATION OF THE URETERS

Catheterization of the ureters has always been a difficult procedure and formerly surgeons went abroad to learn it, when they could as well have mastered it at home if they had had the necessary amount of patience. Ordinarily in the past, the practitioner bought a cystoscope and looked for a case to work upon. He at last found one and, not being familiar with the details of the examination, he hurt his patient and did not accomplish the catheterization. After a few more trials, he usually gave it up and put his cystoscope away on the shelf, where it soon became an unused instrument.

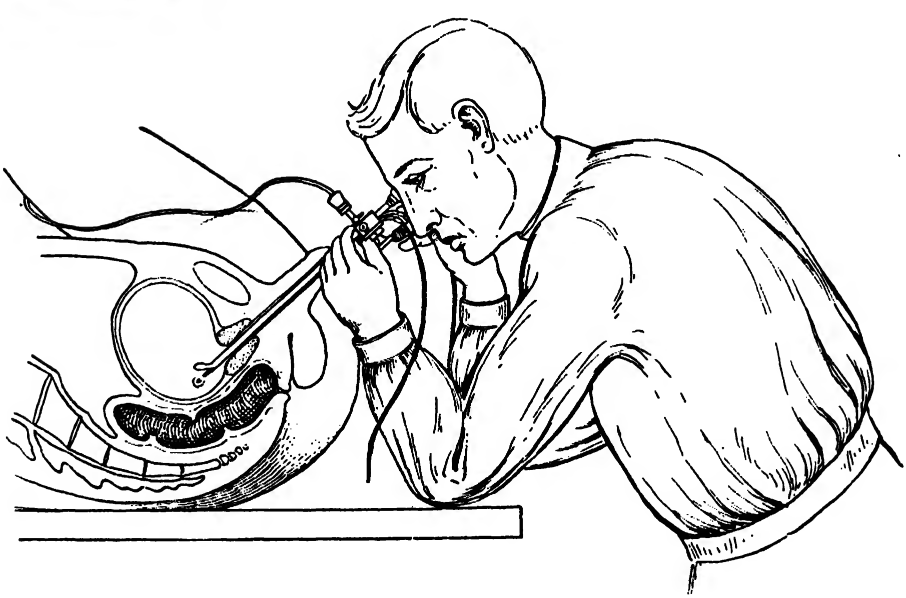
How to Acquire the Knowledge.—It is advisable for the practitioner to buy a phantom (artificial) bladder (Fig. 213) and to practice upon it for a while; or to use for this purpose half of a rubber ball with openings correspond-

ing to the urethra and the ureters. The cystoscope can then be inserted through the urethral opening in the phantom or in the ball and he can practice catheterizing the other two openings.

FIG. 213.—PHANTOM BLADDER FOR PRACTICING CYSTOSCOPY AND URETERAL CATHETERIZATION.

He should then obtain a position in some clinic with the necessary clinical material, and every day he should keep certain of the patients after the others have gone and practice washing out their bladders, examining them and searching for the ureters. After he has found them in the way I have spoken of, he can catheterize them, although it might require three months to find them easily in normal cases (Fig. 214).

In everything that one undertakes in the line of professional work, there are difficulties to be encountered. It is difficult to palpate the pelvic and abdominal organs; to detect the abnormal sounds in the lungs and heart with the stethoscope; to examine intelligently the eye with the ophthalmoscope; to make a diagnosis of the condition of the larynx; to see the



214.—CATHETERIZATION OF THE URETERS. The relative position of the cystoscope to the ureter and the operator just about to push the catheter in by the direct method.

posterior nares, or to catheterize the Eustachian tubes. It is also difficult to cystoscope a patient and catheterize the ureters, and one must not be discouraged because he fails and hears those who have acquired the art speak of it as easy. It must be remembered that no one is born a cystoscopist and that everyone who learns cystoscopy causes more or less harm to patients' bladders before he becomes proficient.

I have seen the most expert surgeons fail to catheterize the ureters after trying for an hour and a half. I have seen them at times fail in two cases out of three even after they have had long experience.

In order to acquire the cystoscopic eye and the cystoscopic fingers, one must look many times into the bladder and into many bladders. He must cultivate persistence, patience and precision. It is easy for a man in a large city to learn,

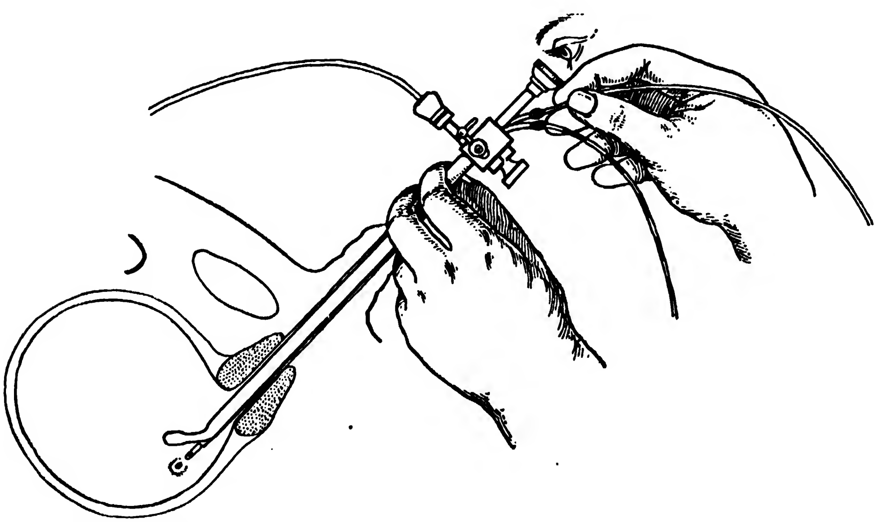


Fig. 215.—The Same Position as in Fig. 214, to Show the Position of the Hands in Catheterization.

if he is willing to take the time, for, after trying a number of times without success, he can go to one of his friends interested in that branch who will show the way; but in smaller communities it is more difficult, and one is more easily discouraged if he is not persistent. A well-known surgeon in a city of 150,000 inhabitants in which there was no one who could do cystoscopy or catheterize the ureters, cut both ureters in doing a hysterectomy. He concluded that if the patient had had catheters in the ureters, the accident would not have happened and he accordingly bought an air-catheterizing cystoscope. He examined bladders religiously for one year before he could see the ureters. He was then able to find them and he catheterized fifty successive cases before doing hysterectomy. He accomplished his purpose and for a long time was the only thorough cystoscopist in his city.

The Instruments.—At present all the models of catheterizing cystoscopes made in this country have the double canal and can be used for observation as well; therefore, in considering the subject of catheterizing the ureters, only the double-catheterizing instruments will be mentioned. The ureteral catheters should be Nos. 6 to 8 French scale, the latter being the better size to prevent the leakage of urine along the sides. A catheter with a tip No. 6 French gradually increasing in size toward the proximal end is most desirable.

THE DIRECT INSTRUMENT.—The ureters having been seen as outlined under cystoscopy, a catheter is first passed up the ureteral opening on one side and then the instrument is moved along the interureteral band to the other ureter, and the remaining catheter is pushed up in the same way (Figs. 215, 216).

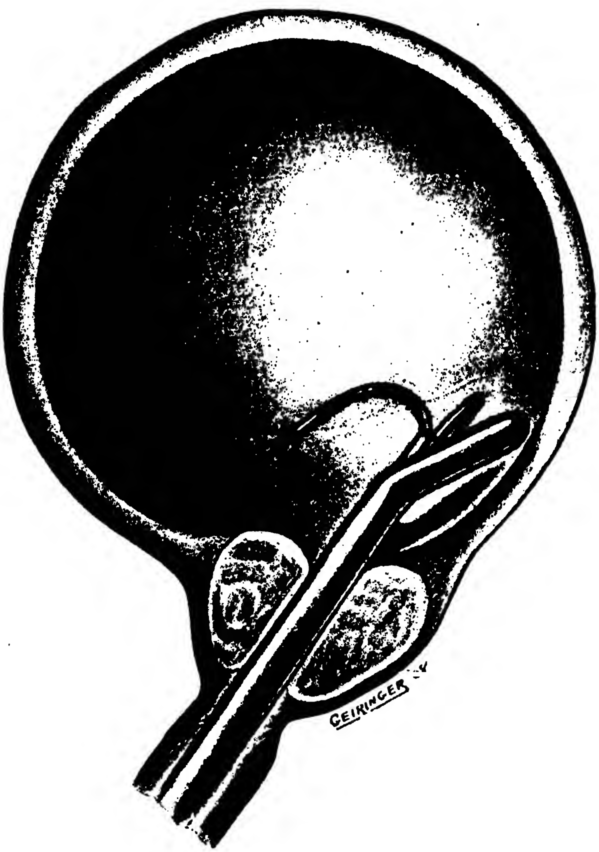


FIG. 216.—CATHETERIZATION OF THE URETERS. The right ureter has been catheterized by the direct method and the beak of the instrument moved across the interureteral band with the catheter in the left ureter.

The same method applies to the air cystoscope, which is also direct. When the ureteral orifice cannot be seen, more water should be added by the piston syringe, in the case of water cystoscopy; or more air by means of a pump, if the air cystoscope is used.

THE INDIRECT INSTRUMENT.—The Bierhoff instrument is the one used in this description, and presents more difficulties in ureteral catheterization than does the direct instrument, as it is necessary to move the catheter toward the ureter in an angle instead of in a straight line. In other words, one must dip the end of the catheter into the opening instead of pushing it straight in. It must be remembered that, as the image is inverted, the movement is liable at first to appear ataxic, and the examiner must consequently learn to turn the wheel on the side of the shaft in what seems to be the wrong way, in order to make the point of the catheter move in the right direction. The ureters are

at the extremities of the hypothenuse of a triangle represented by the interureteral band, the apex of which is the internal urinary meatus. In looking for the ureters, the floor of the bladder must be compared to the dial of a watch, the central point of which should be that from which the catheter protrudes from the instrument, in which case the opening of the right ureter should correspond to twenty-five minutes before the hour and the left ureter twenty-five minutes after.

When the catheter is in place and the examiner, looking at the ureteral mouth, endeavors to insert the tip of the catheter, he finds that it tends to catch on the side of the trigone, or reach over it. The wheel on the side of the shaft of the instrument is then turned, which projects a knee or finger on the concave surface of the instrument near its base in such a way that it moves the end of the catheter in front of the ureter mouth. When the catheter tip has reached this position, the fingers are removed from the wheel and grasp the catheter and gently push it into the ureter. The finger is then turned down again and the other ureter is located. During this latter procedure, the first catheter moves entirely out of the field of vision, and may be entirely disregarded by the operator. The second ureter is now catheterized (Fig. 217), the knee again turned down and the instrument turned so that the operator may assure himself, before withdrawing it, that both catheters are *in situ* (Figs. 218 and 219). The cystoscope is then turned within the catheterizing portion, so that the beak points toward the median line of the abdominal wall, the catheterizing portion meanwhile being held, and continuing to point downward. The instrument is then slowly withdrawn, its removal being compensated for by a gradual insertion of more

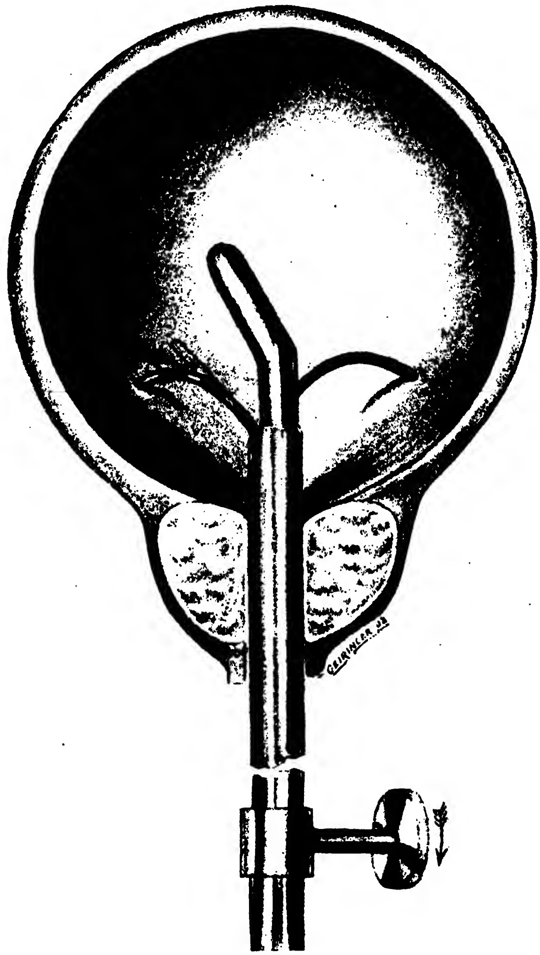
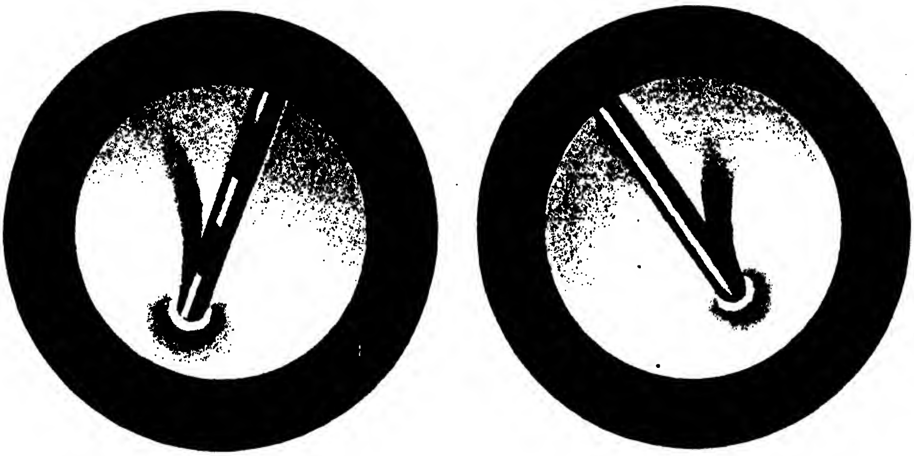


FIG. 217.—CATHETERIZATION OF THE URETERS. The catheter in the left ureter, and on the other side, in dotted lines, the movement of the catheter before entering the right ureter in catheterization by the indirect method.

of the catheters into the cannulæ. When the knees of the instrument, with the catheters, appear at the meatus, the catheters are fixed at the urethral orifice with one hand, and the cystoscope steadily withdrawn with the other. In performing cystoscopy, the catheters should be of different colors, so that they



FIGS. 218-219.—CATHETERIZATION OF THE URETERS. THE CATHETERS *in situ.* In the first figure the ureteral catheter points to "twenty-five minutes before the hour," and in the second to "twenty-five minutes after."

can be easily distinguished from one another, as a black and a brown, or a black and a striped catheter. The collecting bottles should also be marked *right* and *left*. It is thus an easy matter to distinguish and collect the separated urines. With the present system of lenses in the Wappler cystoscopes the image is not inverted and the catheters can easily be introduced without resorting to the maneuvers just described.

Should the urine become turbid during the course of the examination, the catheters should be withdrawn and rubber tubes attached to the irrigating nozzles connected with the cannulæ, after which the solution should be forced through one of the tubes from a fountain or piston syringe. The streams then, flowing through separate tubes, are kept distinct, and the one tube may be used for the inflow, the other for the outflow. In refilling, after irrigation, one stopcock is closed, and the bladder filled through the other tube.

The Rhythm of Ureteral Secretion—How to Remedy It When Interfered with.—After the catheters are inserted, the plugs, if used, are removed from the ends and the urine is collected in different test-tubes or bottles. Normally the urine will be seen to come in dribbles, interrupted periodically, each dribble consisting of about ten or twelve drops. If the urine does not flow from one side, it is probable that the catheter is blocked with pus or mucus, and should be aspirated. If this is not successful in reëstablishing the flow, a small but measured amount of boric-acid solution should be injected to clear the cathe-

ter, by means of a hand syringe inserted into the end of the catheter. It must be noted whether this all comes away or not and its appearance after it comes away as compared with the solution before injection. A clear fluid injected and a turbid one coming away would indicate pus; a bloody one coming away, hemorrhage; a less amount of turbid fluid coming away would show that some *débris* has plugged the catheter. If the fluid comes away clear, it shows that the pelvis is normal. If no fluid enters, it shows that the catheter was plugged before using it and it should be withdrawn and cleaned, or else another one used. This shows the importance of testing the catheters always before using them and washing them out immediately afterwards. If but one ureter can be catheterized, a soft-rubber catheter should be left in the emptied bladder to collect the urine from the other kidney.

The catheterization of both ureters at the same time is very important, as it shows us the comparative secreting activity of the kidneys. We know that the kidneys secrete normally about forty-eight ounces of urine in twenty-four hours; or that each organ will average an ounce an hour. This gives a certain standard for us to compare the urines with, although we know that there are certain conditions depending upon ureteral catheterizations which influence in a way the secretion of urine. Changes in the rapidity of secretion of the two specimens, of the color and the clearness are also noted, as well as the appearance of the coloring matter in case it is given for testing the function of the respective kidneys.

If, on inserting a ureteral catheter into the pelvis of the kidney, a few drachms of urine of normal appearance pours down from that side, it is a case of renal retention; whereas, if it be of a whitish, turbid flow, pyonephrosis is probably present in that kidney.

The primary purpose of ureteral catheterization is the determination of the presence of both kidneys, their function and a comparative examination of the urine from each. After the urines from each side have been collected, they should be examined separately, and the examination recorded on blanks marked *right* and *left kidney*.

Diagnostic Value of Ureteral Catheterization in Ureteral Diseases.—Ureteral catheterization, furthermore, is useful to recognize the presence of and to locate obstruction in the ureter due to strictures, bends or kinks (movable kidney), valvular formation, stones and the pressure of bands of adhesions or adjacent tumors. Furthermore, this procedure may be employed for the diagnosis of inflammation, distention or suppuration in the pelvis of the kidney.

Ureteral Catheterization as a Therapeutic Procedure.—As a therapeutic procedure, catheterization may be resorted to for the purpose of increasing kidney drainage by dilating the narrowest parts of the ureter; for the purpose of irrigating and treating the ureters and the pelvis when they are inflamed. A

catheter in the ureter can also be employed as a guide in some abdominal and pelvic operations, and as a means of permanent drainage. By introducing a catheter, provided with a silver or lead mandrel, and then exposing the abdomen to X-rays, the course of the ureter can be accurately mapped out and strictures, calculi or displacements of the renal pelvis can be detected.

The Importance of Ureteral Catheterization in Pelvic Operations.—Ureteral catheterization is also an important step, prior to hysterectomy, in cases of malignant growths of the uterus, as the independent tumors in the abdomen, not connected with the kidneys or ureters, can thus be made out.

Dangers and Complicatons of Ureteral Catheterizations.—These are generally slight, provided two conditions are fulfilled. The first is not to work too long on any one occasion, but, if unsuccessful after working a short time, to have the patient call again and to repeat the calls until the catheterization is successful. The second important point is to be careful not to use undue violence in the introduction of the instrument. It is needless to mention the importance of as perfect asepsis and antisepsis as possible, both in the preparation of the bladder for the eucain or cocain, and in every manipulation connected with the procedure.

It is remarkable how rarely infections of the pelvis and ureters occur if proper precautions are taken in catheterizing the ureters. At the Post-Graduate Clinic, where several hundred cystoscopies and ureteral catheterizations have been performed in the past few years, no distinct cases of renal or pelvic infection following ureteral catheterization have been noticed, although numerous attacks of urinary fever have followed in patients whose urethra, bladder or kidneys were already infected. The prophylactic injection of solutions of silver nitrate, 1:2,000, with a syringe through the ureteral catheter and into the pelvis of the kidney, and the washing of the bladder with the same solution after every ureteral catheterization, has been carried out in these cases as a matter of routine. This has proved to be a useful precaution against the extension of existing infections and the prevention of a new infection.

It must be remembered that a certain amount of blood and a certain number of ureteral epithelia are often found in the catheterized specimens of urine, simply as a result of the mechanical effect of the catheters upon the mucous membranes. This should be borne in mind in judging the results of the urinary examinations of the separate urines.

Ureteral catheterization has now become so universally recognized as a method of diagnosis and treatment, that it is no longer necessary to plead in its favor or to refute the attacks which have been made upon it by surgeons who were so conservative that they did not care to employ this procedure. The technique is difficult to acquire, but with practice, patience and perseverance, there is no reason why anyone possessed of moderate dexterity, cannot become expert.

EVOLUTION OF CYSTOSCOPY IN THE AUTHOR'S CLINIC

For a long time, although there were assistants in the clinic who had studied cystoscopy and ureteral catheterization abroad, the cystoscopy was performed by me alone and none of them could catheterize the ureters. To remedy this state of affairs, I accordingly established a cystoscopic room, which was probably the first one in this country, connected with a clinic for routine cystoscopy. Now every assistant coming to the clinic has to go through a certain course of service—three months in each department of the clinic—so that it requires from one to two years for him to reach the cystoscopic room. Here he is on duty for three months, washing out bladders and preparing patients for cystoscopy, and then for three months more in performing cystoscopy and in catheterizing the ureters, at the end of which time he has become very proficient.

The result has been that we have developed a cystoscopic school and some of the most expert cystoscopists in this country have served terms in our clinic.

It requires about six weeks for each man to become acquainted with the bladder, and six weeks more for him to be able to catheterize the ureters. Formerly, physicians returning from Europe were constantly telling us about the dexterity with which certain surgeons abroad, who taught them, could catheterize the ureters. When they attempted to show their technique, however, they usually failed. At present, they find that our methods of catheterization are the simplest and that our cystoscopists have more speed than those in Europe. On one occasion when the question of quickness was being discussed by a body of men visiting the clinic, I requested the cystoscopist in charge of the room to illustrate the speed of our American method. He filled the patient's bladder with solution, inserted the cystoscope and catheterized both ureters in twenty-nine seconds.

I do not approve of these trials of speed and it was the only time in our work of ureteral catheterization in the clinic that it has been indulged in, as I feel that, while showing the dexterity of the operator, it detracts from the careful and conservative methods which it is our endeavor always to carry out in bladder work.

After the cystoscopic examination, either for observation or ureteral catheterization, is finished, the patient is again placed in the horizontal position, a catheter is introduced and the bladder is emptied, after which it is washed out with a 1 : 4,000 solution of nitrate of silver, as is also the urethra.

Fifteen grains of urotropin in a glass of water is given by mouth, and a suppository is inserted containing ten grains of quinin and one quarter of a grain of morphin to prevent an attack of urethral fever.

Fig. 220 is a chart showing bladder laid open, used by me in depicting bladder lesions seen by cystoscopy.

Reaction after cystoscopy is due to the patient's spasmodic resistance to the passage of the instrument through the urethra, which causes a traumatism and consequently a urethral fever in case the urine or the canal is infected. This is intensified in a damaged condition of the kidneys. A slight reaction may

FIG. 220.—DIAGRAMS OF BLADDER USED FOR KEEPING RECORDS. Shows, on the left, the base, posterior and part of lateral walls, and on the right, the anterior and lateral walls.

occur even though asepsis and antisepsis is perfect, and the bladder and urethra are washed out after it by silver solution, and morphin and quinin solution is given.

QUESTIONS REGARDING CYSTOSCOPY

In concluding this chapter, I will consider the questions that have been so frequently asked me regarding cystoscopy:

(1) Which is the better instrument, the direct or the indirect?
(2) Which is the better instrument, the air or water cystoscope?
(3) Which is the easier to catheterize, a man or a woman?

(1) As to the question, which is the better instrument, the direct or indirect, I will say that the indirect is the better. This is especially true in the hands of the cystoscopist who is an expert in the use of both instruments, as with an indirect you can examine the interior of the bladder better, which is the object of cystoscopy. You can also see and pass the catheter into any ureter that can be catheterized by the direct instrument, besides introducing it into many ureters that cannot be catheterized by the direct cystoscope on account of an enlarged prostate, a displaced or deformed bladder, or a cystocele.

With the direct instrument, it is much easier to catheterize the ureters of ninety-five per cent of the patients, if this percentage can be catheterized; I feel quite certain that they cannot be, the first time, in pathological cases. Once the ureters are seen, the catheters can easily be introduced, as they are simply pushed straight into the openings. The direct cystoscope, however, does not give the examiner as good a view of the entire bladder and, therefore, is not such a good instrument for observation. This led me to bring out the cystoscope that I have described, as it stands for the teaching in the clinic—namely, examine the bladder with the indirect telescope; withdraw it, introduce the direct-catheterizing apparatus and catheterize the ureters.

(2) Which is the better instrument, the air or the water cystoscope? The water cystoscope is certainly better, as the indirect instrument, which is the best general cystoscope, can only be used successfully in a water medium.

There is, consequently, remaining for discussion, only that part of the question as to the relative merits of direct-air and water cystoscopes, and here again I believe that, in the great majority of cases, the direct-water cystoscope is preferable. A bladder dilated with water is more tolerant than when dilated with air, and it is less liable to traumatism, as the maneuvers are made in a field full of an antiseptic solution.

Formerly the air cystoscope could not be used, as the cystoscopic lamps were too hot and would burn the bladder, and cystoscopy had to be performed in a water medium. The advent of the Mignon cold lamp, brought out by Preston of the Electro-Surgical Company of Rochester, and introduced into the instruments devised by Dr. Koch and Dr. Lewis, made air cystoscopy practical, on account of the bladder being able to tolerate the cold lamp.

There are advantages that an air cystoscope has in certain cases, as, for instance, when a large amount of pus is coming down the ureter from a kidney and clouding the fluid in the bladder or when blood coming from the kidney renders the fluid medium difficult to see through, in either of which cases the diseased kidney would be determined and the ureters easily catheterized by the air instrument. It is also valuable in certain cases of cystitis with bladder sacculation. In the treatment of certain conditions, it should be more suitable than the water instrument, as in curetting or cauterizing ulcers of the bladder.

It is, however, a more difficult instrument to use than the water cystoscope, as the patient complains of pain, and is kept in position with difficulty; while the leaking of air, and the bubbling up of air and urine disturbs the composure of the examiner. These causes have been sufficient to make the majority of the practitioners who have purchased the instrument put it away, and its use is limited to the specialist with an abundance of material. There is, however, a great field for the air cystoscope if alterations can be made by which the pathological field in the bladder can be kept sufficiently smoothed out by air dilatation to allow operative work to be done through the instrument. A cystoscopist

should, therefore, be able to use the direct and indirect water, air and catheterizing cystoscope equally well, in order to be proficient in his specialty.

(3) Which are the easier to catheterize, men or women? This may be answered by stating that it is easier to introduce the instrument into the female bladder than into the male, but once introduced it is more difficult to make the examination in the female. This is because, in the female bladder, the landmarks are not so clearly defined, and also because, in women, the pelvic contents are not always normal, especially the internal genitals. Uterine displacements change the shape of the bladder and its relations, as do fibroid tumors, the adhesions of exudates about the tubes, the presence of ovarian tumors and the prolapse of the posterior wall in cystocele.

CHAPTER XI

SPECIAL URINARY SYMPTOMS

I. DISTURBANCES OF MICTURITION

Frequency of Urination

(*Pollakiuria*)

Frequency of urination is perhaps the most common form of urinary disturbance. The normal frequency of urination varies somewhat in different individuals and at different times. A healthy person, with a normal urinary tract not pressed upon or interfered with by anything outside of its walls, passes urine five times a day without any difficulty or pain, and with a stream of good size which can be started or stopped at will. At the end of the act, the bladder is empty and no sense of discomfort will be felt in any part of the tract. Urination usually takes place on arising; at the time of the stool; before the midday meal; before the evening meal and on retiring.

The *temperature* plays an important rôle in the frequency of urination. During the hot weather when the skin is active, much fluid is taken from the body in the perspiration and the amount of urine and the frequency tend to diminish, excepting when the individual is in bathing, when the desire is much increased. In the autumn, the skin becomes less active, additional work is thrown upon the kidneys and the frequency is increased. Wetting the feet in the fall of the year or chilling of the legs increases the amount of fluid voided by producing a congestion of the internal urogenital tract and, therefore, an irritability of the urinary organs bringing on the desire. Autumn frequency is often caused by sitting or standing quietly watching some game or other object of interest, when the circulation is active and the extremities, on account of not being well covered, are chilled. This tendency disappears during the winter when the extremities are better protected by heavier clothing and overcoats. The frequency, perhaps, returns in the spring from a different cause—the sudden beginning of active perspiration which takes a certain amount of fluid from the urine and renders it more concentrated and irritating.

The *amount of exercise* has the same effect as heat, in that it increases the activity of the circulation and consequently perspiration, when the quantity of urine is temporarily diminished.

Mental emotions give rise to many varieties of frequency, which may show themselves in an unexpected desire to urinate, as in the case of sudden fright. At other times frequency is increased when waiting to take part in some event, competition or game, in which the participant is especially interested; in which case, before beginning, it may be necessary to urinate three times in an hour, whereas perhaps a few minutes after the affair is over, the desire is gone and will not occur again for several hours.

Mental association or continuous thought centered upon the urinary organs may have the same effect, as students working on the subject either in a literary or clinical way, but especially the former.

Pathological frequency of urination or bladder irritability is a condition in which the urine is not only voided more frequently than normal, but in which the desire to urinate is present again soon or immediately after voiding it. The frequency of micturition observed in disease is variable, ranging from six urinations in the daytime and one at night, to an almost continuous desire, or a micturition every few minutes.

Etiology.—Frequency of urination is due to troubles independent of the urinary tract; to diseases of the urinary tract; to affections outside of the urinary tract that interfere with its (the urinary tract's) function.

(1) Diseases Independent of the Urinary Tract.—The diseases independent of the urinary tract causing frequency of urination are those of metabolism, as diabetes mellitus and insipidus, giving rise to overproduction of urine; nervous disorders, as hysteria, neurasthenia and hypochondriasis producing an increased amount of urine; or the character of the urine itself, as a highly acid urine or one containing an increased amount of uric acid, oxalate of lime or indican, the results of faulty metabolism through irritation of the kidney and the consequent polyuria.

Frequency may also follow certain articles of diet, as pepper and other condiments; an abundance of spring water; mineral diuretics, alcoholic drinks, especially gin and beer; certain foods giving rise to intestinal fermentations, as sweets, fried food, onions, radishes, cabbage, tomatoes; also a diet too rich in meat which may give rise to intestinal putrefaction. These articles of food, if not properly digested, give rise to the products of faulty metabolism already mentioned: indican, uric acid, diabetes, oxaluria, etc.

(2) Diseases of the Urinary Tract Giving Rise to Frequency of Urination.—The diseases of the urinary tract causing this trouble are situated above and below the middle zone of the bladder, principally in the latter. Above this zone, we have the kidney, which causes pollakiuria, owing to a polyuria. The polyuria is generally due to an interstitial nephritis, to a tubercular nephritis in its early stages and sometimes to the irritation of a renal calculus. An intermittent pollakiuria is sometimes present in the case of a movable kidney that has become displaced, where there is an intermittent hydronephrosis, which

on its return to position pours out a sufficient amount of urine to give rise to frequency for a brief period.

The bladder is, however, usually responsible for frequency of urination, due to a congestion or inflammation of its wall as a result of the irritation from a foreign body, as a calculus in its cavity, from tubercular deposits or ulcers in its wall, from tumor, or indirectly from the back pressure owing to some obstruction in the tract below, as the prostate or the urethra; or from an extension of an inflammation from the urethra.

Most of the troubles in the bladder giving rise to frequency, are those situated in the part below what would correspond to the middle zone of an organ in health when full of fluid. This would include the base or fundus from the internal meatus to a line above the interureteral band, thus including the trigone.

A *calculus* in this position when the patient is standing, sitting or moving about, would give rise to irritation and consequent congestion of the bladder nearest the internal meatus; while at night, when he is sleeping, it would fall away from the posterior wall of the bladder and the patient would be comparatively comfortable. The shape and surface of the calculus influences frequency, as calculus with a smooth surface that does not come in close contact with the internal meatus produces a less degree of frequency.

Vesical tuberculosis resembles closely vesical calculus in the day frequency, excepting that the stream is not interrupted, as it often is when stone is present; but at night the frequency continues in about the same degree. The frequency in this disease is very great when there is an ulcer near the internal meatus and consequently over the vesical sphincter; whereas, when ulcers are farther away from it, the urgency is much less marked. In vesical tuberculosis, before ulcers have formed, the frequency is not so great.

Vesical tumor does not usually cause such marked frequency as either calculus or tuberculosis, as it is not generally situated near the vesical outlet.

In all three of these conditions, there is congestion, in the first due to the irritation of the stone, in the second about the tubercular deposits and in the third in and about the tumor. In all these conditions, the closer the contact of the pathogenesis with the internal meatus, the more marked the frequency. The symptoms are also more severe after a cystitis has developed.

Impediments to urination also give rise to frequency in different ways and in different degrees.

When a bladder has to force urine through a canal in which there is a narrowing in some locality, or where its shape has become changed through pressure, an extra strain is brought upon it and consequently an extra amount of blood is brought to its walls, resulting in congestion. If this impediment is temporary, the bladder quickly regains its normal condition, after it has subsided, and the frequency is consequently of short duration and of a varied de-

gree. If the impediment is slight at the start and increases slowly, then the bladder becomes accustomed to it and slowly hypertrophies; the congestion is then not marked and the frequency develops slowly and insidiously. If the impediment interferes with the urination to such a degree, owing to a mechanical obstacle or a weakened state of the bladder wall, that the bladder cannot completely empty itself and a certain amount of residual urine is always present, occupying a part of the bladder space, then the remainder of the space for the transient urine is consequently lessened and the patient must urinate more frequently on account of this diminished space being filled more frequently.

Temporary impediments to urination are due, first, to an acute prostatitis, principally of the parenchymatous form; next, to that of the follicular type, or to an abscess resulting from either of these forms, or to a chronic prostatitis. In an acute parenchymatous prostatitis, when one or both lobes are involved, the inflamed gland grows up into the prostatic urethra, toward the bladder, the same as in prostatic hypertrophy. This gives rise to frequency of urination on account of the inflammation near the bladder neck, and also on account of the residual urine resulting from the impediment itself and the consequent diminished transient capacity of the bladder. If the prostatitis is follicular, then there is simply a bulging into the urethra of a sufficient degree to give frequency, due to an increased strain being brought upon the bladder to pass the urine through the narrowed canal. In either of these conditions, an abscess may form, giving rise to an increased effort of the bladder to force urine by the impediment, to residual urine or even to complete retention. When the inflammation subsides or the abscess breaks or is evacuated, the frequency disappears or subsides. If it disappears, the disease is probably cured; but if it subsides and the urine is not clear or shreds are present or prostatic leakage, then the disease is not cured and the slight frequency remaining is the result of a chronic prostatitis.

In tuberculosis of the prostate, there is frequency in a varied degree due to the associated prostatitis and urethritis. This is more marked if it extends to the bladder. When confined to the prostate alone, in time it usually subsides.

In prostatic calculus, the frequency also varies in degree and is often very marked, due to an associated prostatitis and sometimes to incomplete retention. This subsides slowly after the stone has been removed.

Exudates about the urethra in any part which may or may not result in a *periurethral abscess*, often give rise to temporary frequency of urination, due to the narrowing from the outside pressure, which disappears when the abscess has been incised or broken. If there is great pressure in the urethra in these cases, there may be complete retention of urine.

Posterior urethritis occurring during an attack of acute urethritis will also give rise to frequency, often in a very marked degree.

It is easy to understand the mechanism of frequency of urination in acute posterior urethritis. Normally, the pressure of a few drops of urine in the posterior urethra, as the result of a slight leakage through the sphincter when the bladder is sufficiently distended, is said to be the real cause of the desire to urinate. The desire to urinate is a physiological phenomena, initiated by a centripetal irritation of the posterior urethra and the neck of the bladder, by a small quantity of urine. When the posterior urethra is inflamed, the irritability of its mucous membrane is increased to a high potential and thus the patient is obliged to pass water frequently.

Frequency of urination slowly increasing is caused by a chronic impediment to urination, as in the case of stricture or prostatic hypertrophy.

A *stricture* may be congenital, acquired or traumatic, and the nearer to the bladder it is situated the more marked will be the frequency. Congenital strictures are usually linear and situated at the meatus or just in front of the *fossa navicularis.* The frequency of urination in children is principally due to this condition and there is generally a history of nocturnal incontinence. If these patients develop a urethral inflammation, the frequency becomes more marked.

Acquired strictures, resulting from a urethral infection, are the most frequent. The frequency in these cases until the stage when residual urine begins, is due to vesical congestion or cystitis, usually the latter. The frequency is more marked, in proportion, during the day than during the night, and increases after dissipation or exposure.

Traumatic stricture is due to a fall and the pressure of the urethra between the triangular ligament of the pubis and the impinging body. This is often severe, giving rise to retention and later, perhaps, to overflow incontinence, or to extravasation of urine. In cases of moderate degree with no complications, however, a mild but steadily increasing frequency will probably result.

Impediment, with residual urine, causes frequency of urination by the vesical congestion resulting from the impediment, and also on account of the lessened bladder space for the transient urine, due to so much of the bladder cavity being taken up by the residual. The frequency will continue to increase in proportion to the amount of bladder space that becomes occupied by the residual urine, and often until complete retention or overflow incontinence results.

In prostatic hypertrophy, the frequency occurs in the same way as it does in cases of acquired stricture and is at first due to congestion from the extra amount of work thrown upon the bladder in its effort to overcome the obstruction. As the prostate increases in size and the venous return flow from the bladder is interfered with, a passive congestion takes place. This is more marked at night; for then the circulation is less active than during the day when

the patient is up and about. The more marked frequency at night thus differs from the frequency of stricture. Later, as the prostate continues to increase in size and pushes up into the bladder, the residual urine increases, and, as the bladder is more encroached upon by it, the space for the transient urine, therefore, is consequently diminished and frequency increases. This increased frequency increases as in stricture, until complete retention or overflow incontinence takes place.

In prolapse of the uterus, cystocele and vaginal hernia, there is also a pouch of the posterior wall of the bladder, giving rise to residual urine and consequently less room for the transient urine; the patient, therefore, passes urine more frequently, just as he would in case of prostatic hypertrophy.

(3) Frequency of Urination Due to Disease Outside of the Urinary Tract Interfering with its Function.—First among these, are the injuries and diseases of the spinal cord and brain (usually the latter), as the sclerosis or tumors press upon them, increasing pressure slowly and causing an interference with their circulation.

Here the innervation of the bladder is interfered with, there is loss of power in its wall, the desire is not so imperative, but the patient feels the necessity of passing urine more frequently in order to avoid dribbling of urine. This increased frequency, the result of mental calculation, increases until there is a larger amount of residual urine and a consequent overflow retention.

Interference from without, when there is no disturbance of the innervation of the bladder, is due to the pressure or pulling of some perivesical tissue with which it is in close relation or to which adhesions have formed.

Seminal vesiculitis causes frequency when the vesicles are enlarged, tense, acutely inflamed or adherent to the bladder. The seminal vesicles are at times very large, the size of the finger, which gives rise to a sense of fullness of the bladder when a small amount of urine has accumulated in it. At other times, the tense feeling of the seminal vesicles is transmitted to the bladder, which lies in front and above them. Adhesions to the bladder, if the walls of the vesicles are thick and inelastic, give rise to a sense of discomfort when the bladder is stretched a little. In these cases, the feeling of discomfort or fullness is transmitted to the suprapubic region. The frequency in seminal vesiculitis, as in stricture and stone, is more marked in the day than in the night.

The uterus, when misplaced, causes frequency of urination. This is especially annoying when it is displaced forward in such a way as to rest on the bladder, and by its position causes a feeling of discomfort to such a degree, when a small amount of urine has accumulated in it, that, in order to be relieved, the patient must empty the bladder.

Again, when the uterus has fallen back and pulls the bladder with it, there is a feeling of discomfort from pressure on the pelvic plexus of nerves, from interference with the function of the bladder, and perhaps from residual

urine that accumulates in the back of the bladder, resulting in a desire to urinate.

An inflammation of the tubes also interferes with the function of the bladder, through holding it to one side by adhesions and interfering with its dilatation and contraction, and consequently causing frequency.

An exudate, infiltration or abscess, due to a pus tube or to a torn or septic uterus, may press upon the bladder from without so as to prevent it from dilating, except to a limited degree, and thus, by diminishing its capacity, necessitate voiding when but a small quantity is present.

Tumors in the pelvis pressing upon the bladder, on account of their weight, shape or size thus interfering with its dilatation, may give rise to frequency. This condition creates a sensation of fullness before the bladder is actually full, or it may be that pressure only allows the bladder to fill partially. Instances of this are fibroids of the uterus, hydatid in the recto-vesical space and appendiceal abscess in the pelvis.

Cancer of the uterus, involving the bladder wall, may also give rise to frequency of urination, through the congestion it causes; through interfering with the vesical contractibility; through the infiltration of its wall; or through the irritation of an ulcerating area.

Malignant tumors of the rectum produce much the same result.

A loop of atonic dilated sigmoid, in case of fecal retention or a sigmoiditis, may press upon the bladder sufficiently to give rise to frequency or even to retention. This is a much more frequent cause than is generally realized. In women, this loop is often caught down and held by adhesions resulting from salpingitis.

The omentum, when adherent to the bladder, may pull it in any direction, thus interfering with its function. This is generally due to pelvic inflammation starting as a salpingitis. It may also pull other tissues or organs against the bladder.

TABLE OF FREQUENCY OF URINATION

A. *Causes Independent of Diseases of the Urinary Tract*

Temperature	In hot weather, due to prolonged bathing in cold water. In autumn, due to diminished perspiration and extra work thrown on the kidneys. In winter, due to wetting of the feet, chilling of the extremities. In spring, when the sudden active perspiration begins, it is due to concentrated urine charged with irritant properties.
Mental emotions	Fear, anxiety, excitement, or thoughts regarding urinary troubles or brought about by clinical or literary work on the subject.

Diet	Condiments, mineral waters, alcoholic drinks. Certain vegetables giving rise to intestinal fermentation. Too much meat giving rise to intestinal putrefaction. The faulty metabolism from this diet giving rise, through indicanuria, uricacidemia, oxaluria and diabetes, to renal irritation.

Diseases of Metabolism:—Diabetes insipidus and mellitus.
Nervous Disorders:—Hysteria, neurasthenia and hypochondriasis.

B. *Dependent on Diseases of the Urinary Tract*

Polyuria	Interstitial nephritis. Tubercular nephritis. Calculous nephritis. Movable kidney (temporary polyuria).
Vesical congestion or cystitis	Vesical calculus. Vesical tuberculosis. Vesical tumor. Prostatic impediment. Urethral impediment.
Interference-temporary	Parenchymatous prostatitis. Follicular prostatitis. Suppurative (abscess) prostatitis. Chronic prostatitis. Tubercular prostatitis. Calculous prostatitis.
Urethral	Acute posterior urethritis. Exudates about the urethra. Urethral calculi. Periurethral abscess.
Interference-slowly increasing	Stricture, frequency due to vesical congestion or inflammation until residual urine begins. Prostatic hypertrophy, due to vesical congestion or inflammation until residual urine begins.
Interference with residual urine	Stricture and prostatic hypertrophy, due to lessened bladder space to hold the transient urine after residual urine has begun to be present. Prolapse of uterus, due to lessened bladder space to hold the transient urine. Vaginal hernia, due to lessened bladder space to hold the transient urine. Cystocele, due to lessened bladder space to hold the transient urine.

C. *Dependent on Diseases Outside of the Urinary Tract Interfering with its Function*

Interference—temporary	Seminal vesiculitis.	
	Salpingitis.	
	Abscess, exudates, infiltrates.	
	Appendiceal abscess.	
Interference—slowly increasing	Hydatid cyst of pelvis.	
	Tumor of rectum.	
	Sigmoiditis or sigmoid retention.	
	Displaced uterus.	
	Uterine fibroids.	
	Sclerosis of the cord	Tabes dorsalis.
		Lateral sclerosis.
Interference with residual urine	Sclerosis of the cord	Tabes dorsalis.
		Lateral sclerosis.
	Injuries and diseases of the brain.	

Consecutive Cases of Frequency of Urination.—In 240 cases coming to my clinic during the winter of 1907, frequency was found to be due to a single cause in 127 cases. Mixed causes, namely, two or more pathological conditions tending by their combined action to cause this, occurred in 113 cases.

List 1

Cases of frequency in which a single condition was found as a cause at the time of the visit.

Urethritis	46
Stricture	25
Prostatitis (including 1 case of tuberculosis)	23
Seminal vesiculitis (including 1 case of tuberculosis)	10
Cystitis (including 3 tubercular)	7
Prostatic hypertrophy	5
Movable kidney	2
Tumor of bladder	2
Stone in bladder	2
Contracted bladder (frequency from diminished capacity)	1
Dilated bladder (transient capacity or diminished space left for urine over the amount of residuum)	1

List 2

Cases of frequency in which a number of pathological conditions were found as contributing causes at the time of the visit.

Urethritis	43
Stricture	38
Prostatitis (including 2 cases of edema and 2 cases of tuberculosis)	80
Vesiculitis (including 2 cases of perivesiculitis)	73
Cystitis	46
Prostatic hypertrophy	6
Prostatic abscess	5
Tumor of bladder	3
Nephritis	5
Pyelitis	4
Pyelonephritis	3
Renal calculus	3
Ulcer of bladder	1
Sarcoma of prostate	1

Note.—In looking at this table, we will see that urethritis was present in 89 cases of frequency, stricture in 63 cases, cystitis in 53 cases, prostatic hypertrophy in but 11 cases, while prostatitis was present in 103 cases and vesiculitis in 93 cases. This can be explained by saying that urethritis, stricture, cystitis, and prostatic hypertrophy are the principal active causes of frequency; whereas, prostatitis and vesiculitis, excepting in the real acute attacks or in tubercular cases, are usually contributory causes. This list was compiled by Dr. Nelson of Cincinnati.

In the list of cases in which we could ascribe the frequency to one cause, the largest number occurred in the following order: Urethritis, stricture, prostatitis, seminal vesiculitis, cystitis and prostatic hypertrophy; whereas, in the remaining cases, there was no marked number under any one disease. Of the combined causes, we will also see that these six conditions were more or less present in the majority of the cases. This list embraces 240 consecutive cases of frequency coming to the clinic during the winter session.

In my hospital work, the causes are different singly and combined; stricture is the most common cause, next acute prostatitis, posterior urethritis, vesical tuberculosis, vesical calculus and prostatic hypertrophy.

Of these, stricture, prostatic hypertrophy, vesical tuberculosis and vesical calculus are generally accompanied by cystitis, while acute prostatitis and posterior urethritis are usually complications of acute anterior urethritis.

Treatment of Frequency of Urination.—Treatment of frequency of urination varies largely according to the cause, and is considered in the various chapters dealing with each of the conditions involved. This leaves but few words to be said regarding the general treatment of functional frequency of micturition.

It is important to keep the feet warm and dry during the fall and winter, to increase the clothing in accordance with the temperature of the air. All excitement which would tend to cause local irritation should be avoided. The diet should be simple mixed animal and vegetable, taking a small amount of a variety of food rather than a large amount of any one kind. Fried foods and sweets should be partaken of sparingly. Condiments, salted and pickled food, should be avoided. Alcoholics should be avoided or restricted. Spirits, ale, beers and champagne, are the worst drinks, whereas red wines are the least harmful. About three pints of water should be taken in twenty-four hours.

In the therapeutic line, hot Turkish baths should be taken twice a week, hot sitz baths before retiring. If there is any fecal retention or trouble with the prostate gland or seminal vesicles, hot rectal douches are better than hot sitz baths.

Massage of the prostate and vesicles is of value in diseases of these organs, unless they are tubercular.

If the urine is very acid, alkalines should be given, preferably acetate or citrate of potash. Of the mineral waters, the most satisfactory in my judgment is Celestine vichy. If much pus is present, urotropin, salol, benzoic acid and benzoate of soda, are the best urinary antiseptics. If there is acute inflammation, santal oil is the best.

For relieving the frequency, especially if spasm is present, the antispasmodics, as belladonna and hyoscyamus, codein, morphin and the bromids are the best.

For bladder irrigation, solutions of boric acid, nitrate of silver or protargol are the best. For bladder injections, small quantities of argyrol, ten to twenty-five per cent, gomenol or iodoform emulsion, are the most efficacious.

The bowels should be kept open by cascara sagrada, salines, such as phosphate of soda, Apenta or some mild mineral laxative waters, and should be assisted if necessary by glycerin suppositories or rectal enemas.

Moderate exercise should be taken.

Dysuria or Ischuria

Dysuria, or ischuria, is a term which, when correctly used, applies to difficulty in voiding urine and may be accompanied by pain and a spasmodic condition of the bladder at its neck, known as tenesmus. Dysuria does not mean painful micturition, pure and simple. Just as dyspepsia stands for an inability to digest food, so dysuria stands for a difficulty to pass the water.

Dysuria may occur suddenly as an unforeseen event; for example, when a stone becomes jammed in the neck of the bladder or when a papilloma of the bladder suddenly twists in such a way as to block the orifice. In other conditions, as, for example, in hypertrophied prostate, in tumors of the prostate and in strictures of the urethra, dysuria often comes on gradually, the difficulty in passing water becoming more and more pronounced.

In the milder forms of dysuria, the act of urination is merely accompanied by a slight amount of exertion in which the accessory muscles, the abdominal and the perineal, are brought into action. In severe forms, the individual may be unable to pass water, except in certain positions, as squatting or leaning over and bracing against stationary objects. In these severe cases, the face may become agonized, red with swollen veins; perspiration appears in beady drops on the forehead, the breath is held and the lips are compressed in the effort at expulsion, which is repeated periodically with intervals of rest and is accompanied often by an involuntary discharge of gas and feces. When the patient is in the squatting position, a prolapse of the rectum of two inches or more may take place.

This is the clinical description of the symptom dysuria as such. Of course, a number of other disturbances of micturition and of allied clinical signs are very frequently associated with this particular manifestation.

Among these, frequency of micturition, retention and overflow incontinence, pain during, before and after the act of urination may be grouped in a syndrome, each element of which can be analyzed and set down by itself as having its own significance.

Dysuria being present, the question arises to what cause it should be attributed? Our first thought, of course, will be the presence of some obstruction which prevents a free and normal outlet of the stream. The chief causes of such an obstruction have already been mentioned. They are stricture of the urethra; prostatic hypertrophy; stones in the bladder or the urethra; tumors of the bladder or the prostate; or acute inflammatory swelling of the mucous membrane of the neck of the bladder or the prostatic urethra.

A form of dysuria depending only upon a spasmodic contraction of the

sphincter may be styled a nervous dysuria. It may be followed later by incontinence and is characterized by an absence of all local evidences of disease of the urinary organs. Whenever such a dysuria is present, a suspicion arises as to the presence of a spinal disease.

Dysuria of inflammatory origin is simple in its mechanism, depending upon the congestion and swelling of the parts, and is usually fairly easy to recognize by the history and symptoms. In the presence of an acute urethritis, the onset of dysuria with painful and frequent micturition is the signal of the involvement of the posterior urethra. It occurs in an intense degree, especially if accompanied by fever, when an acute involvement of the prostate should be feared, unless excluded by rectal examination. When dysuria and other disturbances of micturition occur in the course of a chronic urethritis, we are led to suspect stricture. If the patient is advanced in age, and if the dysuria has been coming on gradually, increasing apace with frequency of urination, we naturally look for hypertrophy of the prostate. A characteristic of the dysuria of prostatics is that the symptom is aggravated at night. Rest in bed, a horizontal position of the pelvis, a sedentary life and the presence of constipation, are all factors which increase the dysuria of prostatics.

One of the most interesting forms of dysuria is that due to stone in the bladder. In this form, patients, instead of being aggravated when lying in bed, are relieved by the horizontal position, while the upright position and any jars or jolts, as in walking or running, in which the stone has a chance to become lodged in the vesical orifice, increases the discomfort.

A temporary dysuria frequently occurs after urethro-vesical instrumentation—as after the passage of a cystoscope, sounds, or other dilating instruments—and after irrigations by the Janet method, or deep instillation of strong solutions of silver nitrate. This should be termed a false dysuria, as it is simply due to irritation and not to a pathological condition, and is usually of very brief duration.

All varieties of dysuria are frequently accompanied by more or less pain, or at least by a sensation of pressure and burning which is quite distinct from that of an exaggerated desire to urinate. The latter is a sensation of pressure or burning, which cannot exactly be called a pain, in fact, can scarcely be analyzed, yet it forms part and parcel of the mixed sensations experienced by patients afflicted with dysuria. In certain conditions, the contraction of the bladder walls in trying to overcome the obstacle, whatever that may be, gives rise to a colicky pain. This vesical colic may be an accompaniment of dysuria. It is characterized usually by a gradual onset, a rapid rise to a climax, followed by a remission. Usually it is located in the body of the bladder, accompanied by intense desire to urinate, and may radiate to the perineum, the rectum or the urethra, or into the hypogastrium, the groin, or even the loin.

Vesical colic is an accompaniment also of retention, especially of the acute

form. It is due to troubles accompanied by residual urine, to lesions seated in the upper zone of the bladder or to that covered by peritoneum; to deep-seated lesions and to perivesical troubles.

CONDITIONS GIVING RISE TO DYSURIA

- Bladder
  - Vesical calculus, especially if it obstructs the neck of the bladder.
  - Vesical tumors
    - Papillomas, if they obstruct the vesical neck.
    - Infiltrated or malignant, if they interfere with dilatation and contraction of the bladder.
  - Acute inflammation of the bladder neck, the congestion of the mucous membrane imparting the sensation that the bladder is not entirely emptied.
- Extra-vesical causes
  - Inflammation outside of the bladder
    - Vesiculitis.
    - Appendicitis with bladder adhesions.
    - Salpingitis.
  - Extravesical pressure
    - Uterine displacement.
    - Pelvic tumors
      - Uterine.
      - Ovarian.
      - Rectal.
      - Hydatids.
    - Inflammatory exudates.
    - Pressure of sigmoid.
    - Abscess
      - In Retzius' space.
      - Pelvic.
  - Extravesical traction
    - Adhesions of omentum.
    - Adhesions of tubes.
    - Adhesions of large intestines.
- Prostate
  - Calculus in prostate.
  - Tumors of prostate.
  - Acute prostatitis
    - Parenchymatous.
    - Follicular.
    - Abscess.
  - Hypertrophy.
- Urethra
  - Calculus in any part of the urethra, but most marked in the prostatic portion.
  - Acute posterior urethritis, the sensation of obstruction being due to intense congestion.
  - Stricture accompanying chronic urethritis.
- Extra-urethral
  - Periurethral exudates.
  - Periurethral abscess.
  - Urinary extravasation.
- Nervous difficulty due to lesions of the spinal cord.

Painful Micturition

Under this heading, we shall discuss pain which either precedes, accompanies, or follows the act of micturition. This symptom is of the greatest importance in urological diagnosis, as it often enables us to localize and to define the character of urinary diseases.

Micturition is made painful in the presence of congestion, inflammation, ulceration, new growths, calculi, foreign bodies or traumatism, either in the bladder, the prostate or the urethra.

There is, however, a group of conditions of the kidneys and the ureter which indirectly give rise to painful micturition. Of these, perhaps, the most prominent is due to stone in which small calculi pass down the ureter and stick just above or at the opening into the bladder, giving rise to a sensation akin to those in the bladder, the prostate, or the urethra.

Painful micturition is a prominent accompaniment of cystitis. In the milder degree, especially of the chronic type, it is not very pronounced. In the acute form, the pain is very distressing and the same may be said of the tubercular form, especially when accompanied by ulceration. In tumors of the bladder, painful micturition is also one of the important symptoms, becoming marked when the new growth involves a large portion of the organ and when it ulcerates.

Stones or foreign bodies in the bladder, especially if they be rough or pointed, may cause intense pain during the act of micturition.

The rule is, so far as the time of occurrence of the pain is concerned, that, in bladder conditions, the acme of intensity is reached at the end of the act of expulsion—that is, when the greatest amount of vesical contraction takes place.

The character and the position of the pain during micturition, when due to bladder conditions, is not distinctive. It may present itself as a tenesmus or burning sensation at the neck of the bladder, or it may be located in the hypogastrium, radiating to the end of the penis, the groin or even the loin. The pain of stone in the bladder is characteristically located at the end of the urethra.

In posterior urethritis and in inflammations of the prostate, painful urination, accompanied by dysuria, and frequency, constitute a very frequent and important set of symptoms. Usually the pain is felt at the beginning of urination, when the posterior urethra is distended by a rush of urine. The contraction of the posterior urethra at the end of micturition causes an exacerbation of the pain at that time.

Painful micturition may also be present without any organic affections of the urinary organs, when the character of the urine is such as to irritate the lower passages. Among these conditions may be mentioned phosphaturia, oxaluria, uricacidemia and other conditions in which there is an excess of crystalline elements in the urine.

PAINFUL MICTURITION

(1) Ureter:—Calculus near or at the opening into the bladder.	
(2) Congestion or inflammation of the bladder (cystitis) due to	Vesical calculus, especially if rough or pointed. Vesical tuberculosis with ulcer near the urethral opening. Vesical tumor, especially when malignant or ulcerating, or if it comes in contact with the urethral opening. Vesical ulcer. Impediment from below, pressure from without, displacement or an interference with its functions.
(3) Congestion or inflammation of the prostate (prostatitis) due to	Gonorrhea, giving rise to an acute prostatitis. Tuberculosis. Calculus. Tumors (especially malignant).
(4) Congestion or inflammation of the urethra (urethritis)	Gonorrhea Stone Crystals Especially in the posterior portion.

For treatment, see the treatment of the trouble under the special chapters.

Changes in the Urinary Stream

Changes in the urinary stream include alteration in the shape, caliber, force and rhythm of the stream.

The form and direction of the stream is altered in epispadias, hypospadias, fistula, abnormalities of the meatus and other anomalies. There are certain changes in form that are transient and depend upon the gluing of the meatal lips by discharge. In such cases, the stream may be twisted, flattened or split for a few seconds, but when the meatus has been washed by it, the stream again becomes normal.

Persistent changes in the form of the stream indicate the presence of strictures. They may consist of a special twisting, a flattening, or a splitting of the stream into several smaller jets, depending on the distribution, size, or amount of thickening forming the stricture. In stricture, these changes may be accompanied by difficulty in passing water.

The caliber of the stream varies greatly according to the size of the meatus,

i. e., the nozzle through which the stream must pass. If the meatus is narrow, the stream is fine, but when the meatus is normal and the stream is very small, the presumption is that there is a stricture farther back.

The force of the stream depends upon the force of contraction of the detrusor muscle of the bladder and the amount of the obstruction or interference. The force normally depends upon a variety of circumstances. If the bladder muscle is tired by long retention in normal conditions, the stream is weaker. It is also weaker in old people. Any condition which injures the bladder muscles or interferes with free circulation, will cause the force of the stream to be diminished.

The stream loses its force in a variety of nervous conditions, notably in scleroses of the cord (tabes and lateral sclerosis), and in other diseases of the brain and cord in which the action of the detrusor is impaired. In the presence of any obstruction of the stream, there is usually a period of compensation at first, during which an increased muscular action overcomes the resistance, and the stream remains normal in force. Later, however, an atonic condition of the bladder develops and the force of the stream is diminished. This is especially the case in hypertrophy of the prostate, in stricture of the urethra, etc.

In prostatic hypertrophy the bladder wall may be strong and the urethra of large size, as is evidenced after the passage of a large-sized catheter and the escape of a forceful stream of urine through it, and yet if no catheter is passed, the prostatic obstruction will be found sufficient to slow and diminish the force of the stream.

The force of the stream is also lessened when the bladder contractions are interfered with, where there are adhesions of the omentum, tubes or intestines to the bladder, displacements of the uterus, pressure of pelvic tumors and inflammatory exudates.

The rhythm of the stream means its normal uninterrupted flow, beginning with a strong, steady stream and gradually diminishing. The last drops are then expelled by a contraction of the accessory muscle. In old people, the last part of the act is considerably less forceful and the same may occur in people who retain their urine for a long time.

Interruption in the stream of urine, known sometimes as urinary hesitancy, or urinary stammering, occurs in a variety of conditions. These include many in which there is dysuria, the interruption then being due to a necessary relaxation of the auxiliary muscles of micturition. Another cause of interruption of the stream is a spasmodic contraction of the vesical sphincter, such as occurs in acute inflammations in and about the neck of the bladder, as, for example, in acute prostatitis. Finally, the stream of urine may be interrupted in cases in which the bladder itself is free from disease, as in spinal diseases in which the vesical reflex is increased, causing a contraction of the sphincter during the

act, which interrupts the stream. Inflammations of the rectum, acting reflexly upon the bladder, may also produce the same effect.

When small stones, pediculated growths, or tonguelike projections of prostatic tissue are present, the stream may be interfered with.

Retention of Urine

This term designates an inability on the part of the bladder to empty itself, because of loss of power or obstruction. It is variously classified as complete or incomplete, according to the degree of retention; acute or chronic, depending upon the duration and severity of the attack; and traumatic, paralytic or obstructive, referring to the nature of the cause.[1]

Complete retention, from whatever cause, is a condition in which the patient cannot pass any urine from the bladder; it is incomplete when he can empty it only in part, a certain residuum of an ounce or more, remaining in the bladder. The urine which passes represents the excess over this residuum, or the transient urine. Acute retention occurs when the patient suddenly finds that he cannot pass any urine, though he may never before have had any difficulty. It is chronic when for a long time he has not been able to empty his bladder; and paralytic when his inability to void urine is due to paralysis of the bladder wall, owing to disease of either brain or cord.

Retention is obstructive when, owing to some growth or impediment in or about the neck of the bladder or at some point of the urethra, either no urine or not all of it can be forced out. It is traumatic when some wound gives rise to an impediment, either within the urethra itself or on the outside, which presses upon it.

Occasional acute attacks of retention may be due to operations, alcoholism, profound temporary stupor, or voluntary refraining from urinating.

The loss of power is variously referred to as paralysis, paresis and atony. There is really very little difference between certain degrees of these conditions. Complete paralysis of the bladder is found when, on account of some brain or cord lesion, it is incapable of expelling any urine; partial paralysis, when the bladder is not able to empty itself fully. Paresis is another name for partial paralysis, and atony is a condition where, through lack of power, the bladder wall cannot force out all the urine. Both in atony and paralysis, the bladder may be constantly distended by urine to a certain extent, perhaps to its utmost limit, as a passive sac, and the excess of this residuum may dribble away involuntarily (overflow incontinence); or it may be expelled in small quantities by repeated acts of urination in the ordinary way, accompanied by great straining and assisted by the voluntary contractions of the muscular wall of the abdomen.

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[1] Guiteras, "Retention of Urine," *N. Y. Medical Journal*, May 20-27, 1899.

The causes of atony are: Overdistention by neglecting to urinate, involuntary retention in cases of fever and coma, and urethral obstructive conditions. The muscular coat of the bladder may be paralyzed from any cause that will induce loss of muscular power in other parts of the body, and the paralysis may affect either the detrusor urinæ, or the sphincter vesicæ, or both at the same time. Power may be diminished or wholly lost, and this impairment of function may be temporary or permanent.

The muscles of the bladder which expel or retain the urine are only partially under control of the will. Thus the contraction of the detrusor is involuntary, being occasioned as a reflex from the stimulus of the urine in the bladder. When sensibility is diminished and the presence of urine no longer acts as a stimulus on the detrusor, the result is urinary retention. The compressor urethræ must relax under the influence of the will before the contents of the bladder can escape.

It is well to remember also that the bladder muscle may be directly paralyzed by overdistention, as already stated, or by inflammation extending from either its mucous or its serous coat.

Causes.—Acute Retention.—Acute or temporary retentions may be due to operations on or about the external genitals, anus or rectum, or upon parts of the body quite distant from this locality, bringing about a spasmodic inability to urinate. It may also be due to acute alcoholism; to large doses of opium, belladonna or hyoscyamus, especially when given by rectum; or to profound temporary stupor, such as occurs in typhoid fever or other adynamic diseases. Voluntary refraining from urinating until the bladder is so full that its walls are unable to contract, as when one is in company where no opportunity is afforded, is also at times a cause of retention. It may also be found in pregnant women, due to some displacement of the uterus, which presses upon the bladder. If it occurs after delivery, it is due to displacement of the bladder or to the effect of long pressure upon its neck during delivery.

Acute attacks may also occur during chronic obstructive conditions, such as stricture or enlarged prostate from various causes.

In the majority of cases, retention is due either to organic nervous lesions or to obstructions involving the urethra or prostate.

Chronic Retention (*Complete or Incomplete*).—Certain organic nervous diseases cause retention.

In paraplegia, in hemiplegia, in locomotor ataxia and in lateral sclerosis, we may have complete or partial retention due to motor paralysis.

In Pott's disease, we may have retention with incontinence, due to paralysis by interference with the vesico-urethral nerve centers.

In injuries of the brain and spinal cord the same applies. These are attended by important changes in the urinary system as well as in the urine. These changes do not seem to be connected with the particular locality of the

injury. They occur almost uniformly, whether the injury affects the lumbar, the dorsal or the cervical region.

In the various forms of spinal sclerosis, there may be more or less complete retention, in the earlier stages of a spasmodic nature (during the stage of excitement), and, later, due to paralysis.

The Obstructive Causes.—They are principally situated in the prostate or the urethra, although vesical calculi may enter the neck of the bladder and lodge there. Displacement and fracture of the pelvic bones, especially of the pubes, may also cause obstruction.

Prostatic causes of obstruction are acute prostatitis, prostatic hypertrophy, tumors, cysts, calculi or tuberculosis.

The urethral cause is usually a stricture. The retention may be due to an acute congestion of the mucous membrane or of the submucous tissue about this lesion, or it may be a late symptom dependent upon the great obstruction offered by the stricture itself. In either case, it is apt to be preceded by a history of fatigue, cold or alcoholic excesses. Spasm of the urethra aids in closing the canal. Foreign bodies or calculi in the urethra may also cause retention.

Atresia is another cause. This may give rise to complete retention in the new born, if the urethra is impervious; or, if it is slightly pervious, the trouble will come on gradually. This latter condition is really a congenital stricture.

Wounds of the urethra also give rise to retention, either by causing a congestion or an exudate which narrows its caliber, or by pressing upon its walls on the outside and thus rendering it impervious.

Extravasation of urine, due to rupture of the urethra from an injury or wound, or to rupture of a urethral follicle, may allow of sufficient leakage of urine into the surrounding tissues, either in the pendulous portion of the urethra or the perineum, to block completely the canal by its pressure.

Abscesses or cellulitis starting in the urethra or surrounding tissue may also exert enough pressure upon the urethra to shut it off.

Symptoms.—The symptoms of retention vary in a marked degree. In an acute attack of retention, such as occurs after an operation or during a fever, the patient complains of pain steadily increasing in the suprapubic region, and of a sense of fullness and inability to micturate, associated with a constant desire. On palpation over the pubes, there is a feeling of tenderness and distention, and perhaps a globular tumor can be seen (Fig. 221), extending up toward the thorax. Rectal examination may reveal a tumor filling the pelvis like a gravid uterus.

Chronic complete retention rarely occurs, as an overflow incontinence usually renders it incomplete. It may be observed, however, in certain cases of paralysis or obstruction. In complete retention, such as occurs in some cases of paralysis, the patient may not have been able to void a drop of urine for

months. There is, however, when the bladder is full, a sensation, or, in cases of paralysis, where sensation is not perfect, a knowledge of how long it takes the bladder to fill, so that the individual knows when the time has arrived to have recourse to the catheter.

In chronic incomplete retention, the symptoms are different, as all cases have residual urine, and the condition often develops so slowly that the pa-

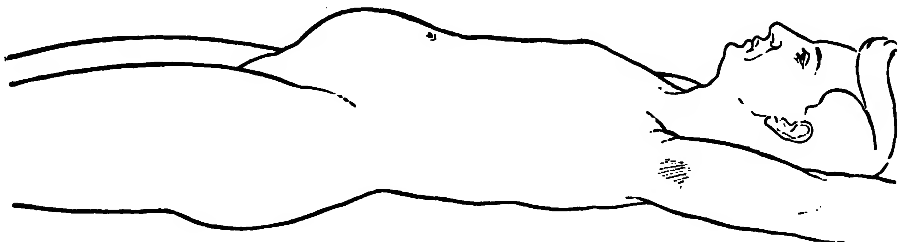


FIG. 221.—THE OUTLINE OF THE ABDOMEN IN A CASE OF RETENTION.

tients do not know that they cannot empty their bladders until they have been so informed by the physician after an examination. A patient with a weak bladder may carry for many years about a pint or more of clear urine as a residual deposit, which its weakened walls cannot throw off. An excess of the fixed residuum produces a desire to urinate, and the patient, mainly by voluntary contraction of the abdominal muscles, is able to void this excess.

In chronic incomplete retention, acute attacks of complete retention occur principally when there is obstruction to the escape of urine in the form of stricture or enlarged prostate.

A patient with prostatic hypertrophy suffers from chronic incomplete retention, in addition to which his bladder is usually atonic and chronically inflamed. The usual symptoms are those of congestion, pain, frequency of micturition, in addition to which the urine is thick and foul-smelling if cystitis has developed. After overeating or drinking, or exposure to wet or cold, these patients suddenly find that they cannot pass urine. As the bladder dilates, they have a feeling of pain and a sense of retention, which is usually relieved by the methods which we shall mention under Treatment.

Cases of acute attacks of retention due to stricture are also common. Here also there is usually a certain amount of residual urine in the bladder. In bad cases, the urethra behind the stricture is dilated, at times even as far back as the neck of the bladder, which itself becomes dilated and no longer acts as a sphincter, giving rise to an overflow incontinence. In such cases, it is often difficult to expel any of the remainder of the urine. Great straining and prolapse of the rectum may accompany the efforts.

In chronic incomplete retention, where the bladder cannot empty itself, cys-

titis usually develops, after which sufficient bacteria remain in the residuum to contaminate the fresh urine flowing into it.

Diagnosis.—When one is called to see a case of suspected retention of urine, it is necessary to ascertain first if it is really retention, and then inquire carefully into the history of the case: whether it is complete or incomplete; and if complete, whether it is an acute attack or not; and if an acute attack, whether the patient has had others of a similar nature. It is then important to know if there is any other symptom, general or local, which may give us some clew as to the cause of retention; also to ascertain age and family history.

To be sure of an attack of retention, there are certain other conditions that must be excluded, as anuria, rupture of the bladder and extravasation of urine.

It is strange how generally anuria and retention are confounded with one another. Anuria is a condition where either the function of the kidney has ceased or the urine is prevented from entering the bladder, whereas, in retention, the bladder contains urine, but cannot empty itself. If no urine can be passed by the urethra, and it is a question between anuria and retention, a bimanual examination per rectum and suprapubically will usually disclose the presence of a large fluid tumor if it is retention, and a catheter inserted into the bladder will draw off a quantity of urine in vesical retention and none in the case of anuria.

Rupture of the bladder can be distinguished from retention, as in the former case there is no well-defined globular tumor present, and a catheter passed by the urethra will bring away only a slight amount of urine and blood. The patient will complain of great pain and tenderness in the suprapubic region and perhaps of strangury. If the rupture extends into the peritoneal cavity, general abdominal pain, an elevation of temperature, and rapid pulse will soon follow.

In extravasation of urine, vesical retention may also be present on account of the pressure of the exuded urine on the urethra and it may be impossible to pass an instrument into the bladder on this very account. The extravasation can be seen as a swelling in the perineum, external genitals, or even extending to the abdominal wall.

The history of a case of retention will reveal a great deal, as will a survey of the symptoms. For instance, if there is history of an operation on the genitals or about the rectum, an acute attack of retention can be ascribed to that source. If the patient has had a stroke of apoplexy, a fracture of the skull, or is suffering from a disease of the cord, or other evidences of paralysis, we can assume that the retention is due to one of these causes. To show that injury to the cord is followed by bladder dilatation, I will quote an experiment of Budge, who found that division of the cord in the lower dorsal region was followed by increased reflex action of the sphincter and a greater degree of distention of the bladder than could be produced after death.

It is rarely that retention is so complete that not a drop of urine can be passed, but we do at times observe cases in complete and partial paraplegia in which not a drop can be voided without the catheter.

Having excluded paralysis as a cause of retention, we should then look for some local trouble to account for it. If the patient is a man over fifty-five years of age, with a history of trouble in urinating, the stream coming tardily, and if he has suffered from such frequency of urination as to be obliged to get up often at night, and if, on certain occasions, he was unable to pass his urine except when aided by a hot bath or by hot local applications, we can assume that he has some prostatic trouble, and can examine him per rectum and per urethra to see if obstruction is present there. If an enlargement is found, it is probably occasioned by senile prostatic hypertrophy. Of course, there are other prostatic troubles that may give rise to enlargement, as acute prostatitis, malignant tumor, tuberculosis and cystic conditions, but these are rare. If the patient is a man between twenty-five and fifty years of age, has had several attacks of urethritis, and has recently urinated with increased frequency and with some difficulty and pain, his urethra should be explored for stricture, and if one of small caliber is found, it is probably the cause of his retention.

Treatment.—The treatment in retention of urine varies and depends upon the cause, form and degree of the trouble, and may be divided into temporary, palliative and radical methods. It is my intention to consider the different forms from the standpoint of degree and cause.

Acute Attacks of Complete Retention.—In acute attacks of complete retention, such as occur after operations in toxic, comatose conditions, or fevers, the surgeon should insert a soft-rubber catheter into the bladder and draw off one pint of the urine. If then hot applications are made over the pubes, the patient will probably be able to pass urine, after an hour, without difficulty. If not, the catheter should again be introduced at the end of two hours, and again every three hours, until spontaneous urination has been reëstablished, drawing off each time only a pint of urine. This will usually take place after a few catheterizations, although sometimes it requires a longer period.

Acute Attacks of Complete Retention Occurring in Cases of Chronic Incomplete Retention.—Attacks of this nature, occurring in people who have a certain amount of residual urine habitually, are those most commonly encountered. They usually occur in men suffering from stricture or enlarged prostate and are generally caused by exposure to cold or wet, dissipation, or by excesses in eating or drinking. Here the patient suddenly finds that he cannot urinate, although he has been able to pass a fair amount at frequent intervals, for some time.

This is a critical moment for him, as it is often here that his future woes begin. A case in this condition should be handled with the greatest care, as the bladder and, perhaps, the ureters and pelves of the kidneys are more or less

distended or congested and in a favorable condition to be infected. The catheterization should, therefore, be made under the strictest asepsis or antisepsis, and care must be taken to avoid lacerating, wounding or bruising. (See chapter on Asepsis and Antisepsis.)

The treatment of these attacks, or exacerbations of chronic ones, is the same as that of an acute attack independent of a chronic condition; namely, to pass a catheter and draw off a pint of urine, another pint in two hours, and then a pint every three hours until the patient can urinate spontaneously, as has just been mentioned. Frequently, however, a catheter will not enter, in which case the patient should have a hot sitz bath, which may enable him to pass a small amount of urine while seated in the water. If, however, he is unable to pass any urine in this way, he should then have a hypodermic injection of a quarter of a grain of morphin, hot applications over the pubes and perineum, and should lie down for about an hour, when another attempt should be made to catheterize him, at first with a small soft-rubber catheter, and, if unsuccessful with such an instrument, then with a woven one with an olivary tip. If the patient is an old man, an elbowed woven catheter should be used. In case these measures do not meet with success, he should be given another hot sitz bath and another attempt at catheterization should be made.

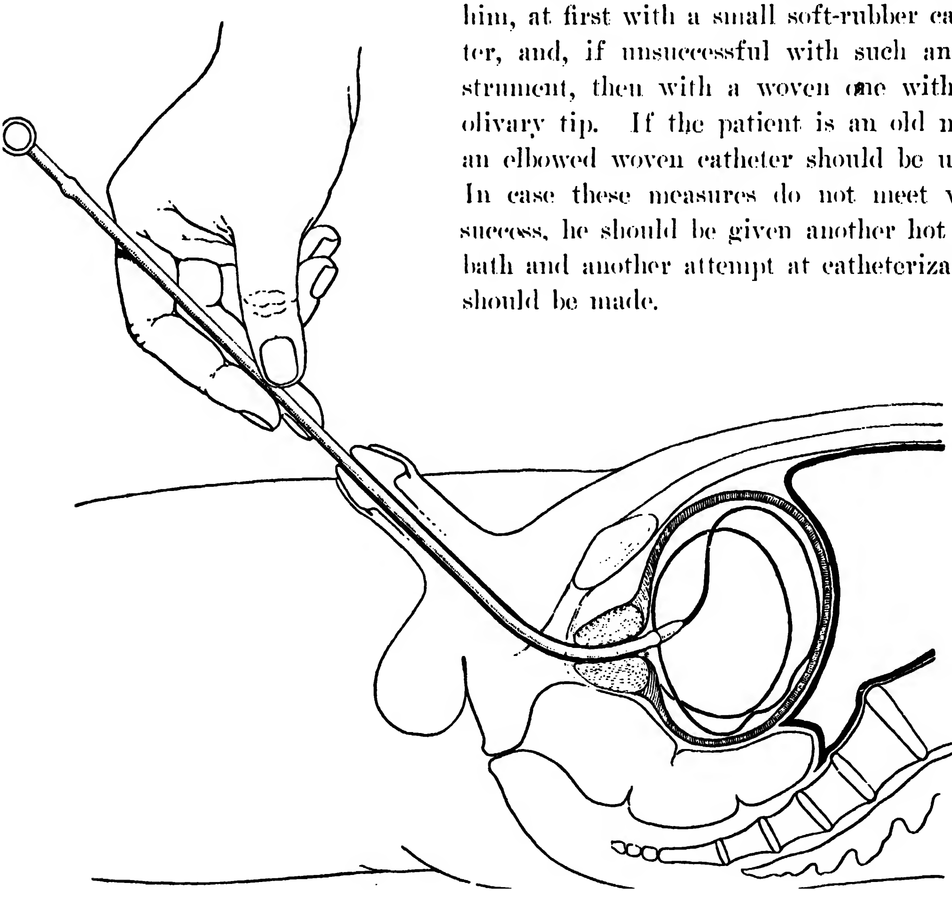


FIG. 222.—THE BLASUCCI CATHETER.
Contains a mandrin with a pliable filiform guide at its end, seen in the bladder.

Sometimes, when other catheters fail, the Blasucci instrument can be passed (Figs. 222, 223 and 224). If this attempt fails and he cannot pass

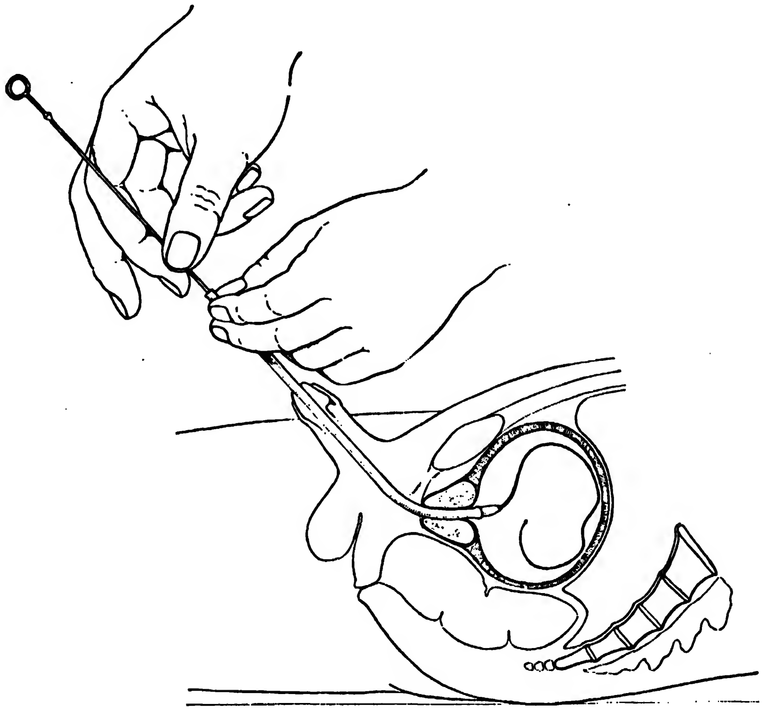


Fig. 223.—The Blasucci Catheter.
The mandrin and filiform are being withdrawn from the catheter.

urine, he should be aspirated suprapubically and a pint of urine withdrawn, after which he should be aspirated every four hours until he is able

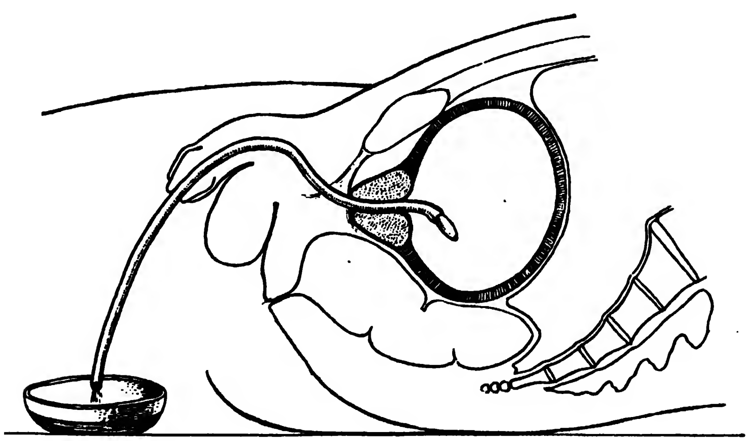


Fig. 224.—The Blasucci Catheter.
The mandrin has been withdrawn and the urine is seen flowing into a basin.

to urinate spontaneously, or a catheter can be passed. In case such a result is not obtained, an operation should be performed, preferably a perineal section. It is very rarely, however, that an immediate operative procedure has to be resorted to, as these patients are almost always able to pass sufficient urine to be relieved if a catheter cannot be inserted. In case it is difficult to pass the catheter at any time, when one finally enters, it is prudent to tie it in for twenty-four hours and insert a plug, which can be withdrawn every two or three hours, until the bladder is empty. In twenty years of the most active practice in bladder surgery, I cannot recall having had to aspirate more than three patients.

The best lubricant is glycerin; next to this, Casper's prescription:

℞	Hydrarg. oxycyanat.	gr. iijss;
	Glycerini	f℥vss;
	Tragacanth	gr. xlvj;
	Aquæ dist. sterilizat.	f℥iij.

The mixture is put up in tubes.

In case a catheter does not easily pass with such lubricants, half an ounce of sterile olive oil, which is more than the anterior urethra will readily hold, should be injected and held in for several minutes in the hope that some of it will pass through the stricture and lubricate its walls. Before allowing any oil to escape from the meatus, while the urethra is still somewhat dilated, an attempt should be made to pass a catheter or filiforms.

If a catheter can be introduced into the bladder, it may be allowed to remain as a retained catheter. It should be plugged, and every two hours, until the bladder is empty, twelve ounces of urine should be withdrawn.

In case neither a soft-rubber nor woven catheter can be introduced, an endeavor should be made to pass a filiform. If successful and some urine escapes by its side, it may be left in place, in the hope that the urine will drain off by its side; or a metal tunneled catheter may be forced over it into the bladder, thus allowing as much urine to be drawn off as we desire.

I do not advocate this latter procedure, however, unless it is considered desirable to operate immediately afterwards.

If a patient cannot pass urine and an instrument cannot be introduced that will allow the escape of urine, then there are but two things to do. One is to perform paracentesis (aspiration), and the other a radical operation.

It is probable that by keeping the patient in bed and resorting to the palliative methods already referred to, he will be able to urinate spontaneously in a few hours, but only in small quantities; or else the congestion will go down sufficiently to allow the catheter to be passed. Patients may be aspirated frequently, each time but a pint of urine being withdrawn; I have known a patient to be aspirated over one hundred times without any ill effects.

Paracentesis should always be performed by the suprapubic route. The point for the introduction of the instrument should be in the median line, just above the symphysis. The trocar should be pushed inward and downward for 'about two inches, the stilet should then be taken out and a certain amount of urine withdrawn (Fig. 225). A piece of plaster should be placed over the puncture and the patient put to bed.

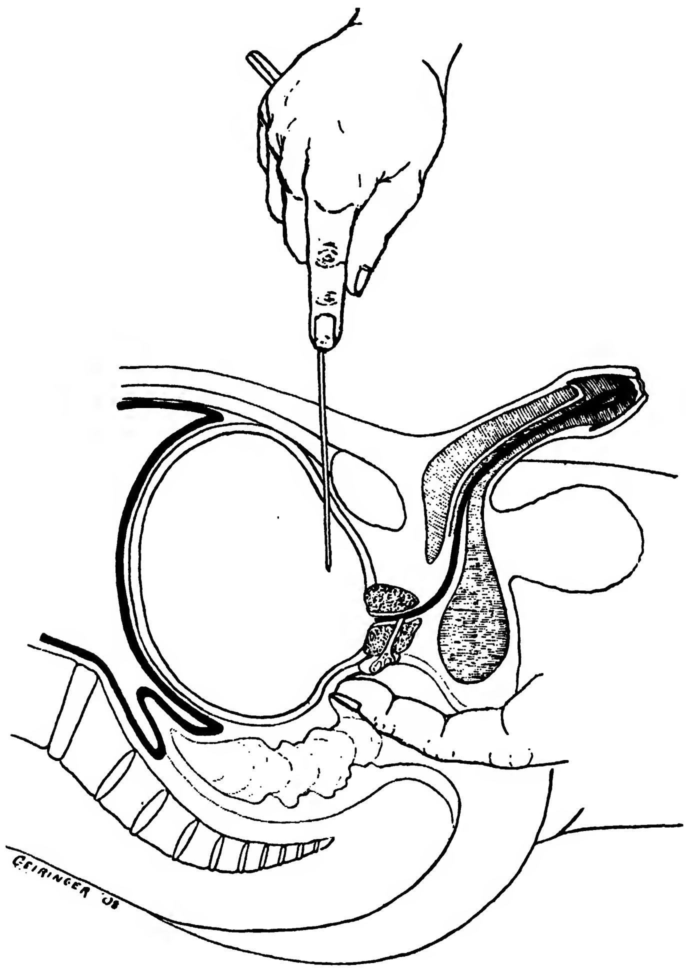


FIG. 225.—PARACENTESIS. The grooved cannula or an aspirating needle is thrust through the abdominal and bladder walls, just above the pubes toward the tip of the forefinger, which is in the rectum just above the prostatic base and acts as a guide.

The complete emptying of the bladder at once may produce a distention of the blood vessels of the urinary tract and a consequent engorgement of its surface. Within a few hours, the urine may contain a little blood (hematuria), independent of mechanical injury. If the urinary tract was infected before or during the catheterization, the temperature may rise, the tongue become dry and

brown, and the patient may develop a condition known as urinary fever. If the patient's kidneys are damaged, even if no infection is present, the kidneys may become congested, resulting in uremia and death. The renal congestion may even give rise to death in a few hours from suppression.

The conservative method recommended of gradually evacuating the bladder may be used with advantage in cases of retention. It consists, first, in evacuating about one pint of urine by catheter, which should be plugged and retained. At intervals of two hours, until the bladder is empty, the plug should be withdrawn and twelve ounces of urine allowed to escape.

Chronic Complete Retention Due to Paralysis.—In chronic complete retention due to paralysis, such as occurs in cases of transverse myelitis, the patient should be catheterized every six hours.

Chronic Complete Retention Due to Obstruction.—In chronic complete retention due to obstruction, the treatment should be the same as in chronic cases due to paralysis, if this is possible. These cases are, however, almost always due to hypertrophy of the prostate or to stricture, so that, in the former condition, we should be obliged to use an elbowed soft-rubber or woven catheter. In such cases, pain, irritation and tenesmus are often so great that the catheter may have to be passed more frequently in order to give the patient relief. Internal urinary antiseptics, bladder irrigations of antiseptic solutions by means of the catheter, and antispasmodics by the mouth or rectum, should be given.

Chronic Incomplete Retention Due to Paralysis.—In chronic incomplete retention due to paralysis, the bladder wall is partially paralyzed, residual urine is present, and cystitis is apt to occur. Here the frequency of catheterization should depend on the amount of residual urine present; if four ounces, once a day; four to eight ounces, twice a day; eight to twelve ounces, three times a day; over twelve ounces, four times a day.

If, in addition to this, cystitis is present, we should wash out the bladder every day or two through the catheter with some antiseptic solution, as one of boric acid or silver nitrate, and give internally a urinary antiseptic.

In all cases of chronic incomplete retention, *the treatment of the inflamed and atonic wall of the bladder* is to be considered. A patient may live for years with a chronic cystitis, if his bladder is treated properly. This trouble is generally not curable, but few inflammatory conditions yield to treatment with more gratifying results to both the physician and the patient.

The methods of toning up an atonic bladder are: By using remedies which will excite contraction of the bladder wall, such as strychnin, cold sponging, or douching over the pubes, and counterirritation to the spine.

Civiale recommended cold-water injection into the bladder, beginning with tepid water and gradually decreasing the temperature to 60° F. This should be done after emptying the bladder. Two or three of these injections may be given one after another. These generally excite contractions, which, once hav-

ing begun, will bring about favorable results. The daily injections for a fortnight will usually cause marked improvement.

The faradic current given by placing one pole over the lumbar or hypogastric region, and introducing the other into the bladder in the form of a hard-rubber sound, with a metallic tip, is often of great service. This should be moved around until it comes in contact with the different parts of the bladder wall for five minutes at a sitting. Various preparations, such as those of iron, strychnin and other tonics, are recommended.

Chronic Incomplete Retention Due to Obstruction.—In chronic incomplete retention due to obstruction, we have a very common condition, such as is usually seen in cases of enlarged prostate or tight stricture. The treatment of the bladder in these cases should depend very much on the amount of residual urine. The bladder should be catheterized as often as indicated and irrigated with an antiseptic solution. A urethral stricture, if present, should be dilated.

Radical Treatment.—The causes of complete or incomplete retention, when obstruction is due to mechanical interference, should be treated by operation, as recommended in the respective chapters on these subjects: urethrotomy for urethral stricture and prostatectomy for prostatic hypertrophy.

The classification of retention of urine is as follows:

<table>
<tr><td>(1) According to the degree of retention</td><td colspan="2">Complete—when no urine can be passed.
Incomplete—when not all the urine can be passed.</td></tr>
<tr><td rowspan="2">(2) Degree of intensity and duration</td><td>Acute</td><td>When the patient suddenly finds it impossible to urinate.
An acute attack taking place during chronic incomplete retention, is really an acute exacerbation.</td></tr>
<tr><td>Chronic</td><td>When the patient habitually, for a considerable time, has not been able to empty his bladder.</td></tr>
<tr><td>(3) Cause</td><td colspan="2">Obstructive.
Traumatic.
Paralytic.</td></tr>
</table>

In the following table I classify them according to acute and chronic, speaking first of the purely acute; then those purely chronic, which will be divided into complete and incomplete.

Acute attacks of complete retention may be due to	Acute parenchymatous prostatitis.
	Follicular prostatitis.
	Stricture or prostatic hypertrophy.
	Alcoholism.
	Temporary stupor.
	Voluntary refraining from urinating.
	Fever, as typhoid.
	Pregnancy.
	Urethral calculus.
	Extravasation of urine.
	Periurethral abscess or cellulitis.
	Fracture of the pelvis.

Chronic retention (complete or incomplete)	Paraplegia, Hemiplegia — From disease or injury.
	Tabes and lateral sclerosis.
	Pott's disease.
	Prostatic hypertrophy.
	Prostatic tumors or cysts.
	Urethral stricture.
	Atresia in the newborn.

In chronic cases of partial retention (that is, when there is residual urine present), the patient may suddenly find that he cannot urinate, thus making an acute attack of retention. In paralytic and chronic obstructive cases, there may be an overflow retention or incontinence.

Incontinence of Urine

Definition.—True incontinence is the involuntary discharge of urine through the urethra. False incontinence is a condition in which an irresistible desire to urinate occurs, causing the patient to void every few minutes, or giving rise to precipitate urination.

Varieties and Causes.—The following table shows the varieties of true incontinence and their causes:

I. Retention with Incontinence or Overflow Incontinence.

(1) Due to an obstruction in the vesico-urethral path	(*a*) Strictures of the urethra, traumatic or acquired.
	(*b*) Chronic enlarged prostate.
	(*c*) Foreign bodies, stones, tumors blocking the path; outside pressure; or cystocele.

(2) Due to a change in the nervous mechanism of the bladder	(*a*) Locomotor ataxia; myelitis; paralysis. (Bladder paralyzed.) (*b*) Comatose conditions; apoplexy; cerebral concussion; narcotic poisoning. (Consciousness of desire abolished.)
(3) Due to a loss of muscular tone of the bladder	Senile atrophy of the bladder.

II. Without Retention.—Due to insufficiency of, or interference with, the sphincter mechanism from the following causes:

(1) Idiopathic or functional	(*a*) Enuresis nocturna in children. (*b*) Nervous and physical incontinence in adults; hysteria; neurasthenia.
(2) Mechanical	Stone or foreign body or tumor in the neck of the bladder, partly holding the sphincter open.

(3) Tuberculosis of the neck of the bladder, giving rise to loss of tissue from ulcerations that prevent its uniform closing.[1]

(4) Traumatic,[2] after	(*a*) Perineal section: For prostatic abscess. For stricture. For perineal prostatectomy. (*b*) Bottini operation. (*c*) Forcible dilatation of sphincter. (*d*) Fracture of the pelvis affecting sphincter.
(5) Atonic, affecting the sphincter only	(*a*) After childbed, with subinvolution of the uterus. (*b*) In old women, with atrophy of the genito-urinary organs.

[1] This condition described by many authorities is probably rare, as the author has never seen a case of true incontinence in vesical tuberculosis that he could prove to be such either by clinical methods or post-mortem findings. Many cases of false incontinence in vesical tuberculosis resemble true incontinence so closely as to be mistaken for it.

[2] Childbirth, with tearing of the vesical sphincter usually given as a cause of incontinence, has been omitted from this table, as in fifty-five thousand (55,000) cases in one of the largest lying-in hospitals in the world, no such case has been recorded. Its presence on the list together with the usual causes might mislead the practitioner for whose use this table has been prepared.

Clinical Features.—The clinical types which can be distinguished are as follows:

(1) Dribbling.

(2) Sudden discharge of entire contents of the bladder at intervals, giving bladder time to fill up.

(3) Discharge of the contents of bladder by steady pressure over it.

(1) DRIBBLING.—This is characteristic of overflow retention in true incontinence. In most cases the accumulation of urine gradually overcomes the resistance of the sphincter and the urine begins to dribble out.

As the bladder keeps filling up, there being usually polyuria in these cases, the dribbling continues, with interruptions. Usually the overflow dribbling of retention appears at night, but later continues through the twenty-four hours. Dribbling may occur without retention in those cases of incontinence in which the sphincter is interfered with. (See Table II, 2, 4.) Sometimes in these cases the discharge of small amounts of urine may be brought about by sudden jars, such as occur in coughing, sneezing, etc., while the bladder may retain its contents during sleep. Slight dribbling is also due to a few drops of urine collecting in dilations behind strictures, in cases in which the bladder sphincter holds.

(2) SUDDEN DISCHARGE OF THE ENTIRE CONTENTS OF THE BLADDER AT INTERVALS, GIVING THE BLADDER TIME TO FILL UP AGAIN.—*The involuntary discharge of large amounts of urine* in a steady stream, from time to time, while the fluid is retained in the intervals, is characteristic of enuresis nocturna in children; of cerebral conditions accompanied by coma; of narcotic poisoning, concussion, epilepsy, etc., in which cases the patient does not feel any desire to urinate, though the bladder be full.

(3) DISCHARGE OF URINE BY STEADY PRESSURE ON THE BLADDER.—This is a symptom indicating the reverse of the above, namely, a lowered reflex susceptibility of the organ, and occurs when the reflexes are generally lowered in locomotor ataxia, myelitis, etc. This form of incontinence is characterized by the fact that the contents of the bladder can be readily expressed when pressure is made upon the suprapubic region. The pressure on the bladder, however, that usually causes such incontinence, is a fibroid or subinvoluted uterus, an abdominal or pelvic tumor, or, in some cases, the weight of the intestines in ptosis, or of the omentum when standing.

Diagnosis.—True incontinence is distinguished from false by the subjective presence in the latter of the desire to urinate. We must be sure, of course, to exclude cases of willful discharge of urine in bed, etc., for the purpose of malingering.

If an examination, general and local, fails to reveal the causes of true incontinence, we can assume that the case is one of false incontinence.

Among the causes of false incontinence are the following: Acute inflamma-

tion of the posterior urethra in very nervous individuals; any of the causes of true incontinence which have not reached the point where they are beyond the control of the will; acute prostatic troubles; and tuberculosis of the bladder. The last-mentioned is the most common and typical of all causes and should always be suspected.

Treatment of Incontinence.—Strictures, where there is but slight dribbling after urinating, due to dilatations behind them, are usually situated anteriorly, and dilatation or internal urethrotomy should be resorted to. In cases in which there is overflow incontinence, the stricture is usually deep-seated and of long standing, and would require an external urethrotomy. When due to enlarged prostate, the gland should be enucleated, or a Bottini operation performed, or catheter life resorted to. Foreign bodies and stones holding the sphincter open and occluding to a sufficient degree, to cause retention, should be removed. Tumors should also be removed if the growth has not involved too much tissue.

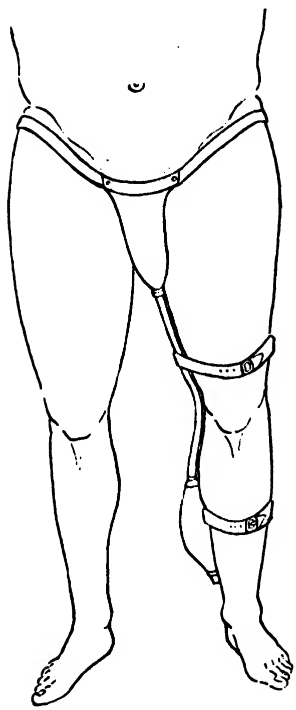


Fig. 226.—The Method of Wearing a Urinal. The rubber urinal is strapped about the hips. The external genitals fit in the pouch below the pubes, from which a tube runs down to a reservoir on the inner side of the leg.

In locomotor ataxia, myelitis and paralysis, the bladder should be emptied four times in twenty-four hours, and should be washed with silver solution and a urinal be worn (Fig. 226). Sometimes in cerebral lesions, the condition improves somewhat, but in diseases of the spinal cord there is rarely any improvement. Cases in which the bladder is atonic should be treated by nitrate-of-silver irrigations, by electricity to the inside of the bladder, injections of cold water and internally by iron and strychnin.

In enuresis nocturna in children, the child, if a male, should be circumcised. He should be examined for a congenital urethral stricture, which should be cut if present. He should sleep with a knotted towel about him and with the knots behind his back. He should be awakened at a certain time to empty his bladder. Internally, he should have hyoscyamus and bromid before retiring. If five years of age hyoscyamin, gr. $\frac{1}{600}$; bromid, grs. v.

In cases of hysteria and neurasthenia, bromid, belladonna and hyoscyamus should also be given.

Fibroid tumors pressing on the bladder should be removed. A uterus pressing upon it should be fixed in place by shortening the ligaments or by anchoring

it to the abdominal wall, well up. Bad tears of the bladder sphincter during childbirth should be immediately repaired. Extensive cuts through the sphincter at the time of operations for stricture or prostatic abscesses, in the Bottini prostatotomy, or in perineal prostatectomy, may give rise to an incontinence, for the treatment of which no satisfactory remedy has yet been devised. Time, electricity, prostatic and vesical douches, and tonic remedies may benefit them; but many of the bad cases are never cured.

Subinvolution of the uterus after childbirth should be treated by curettage and ventral suspension.

In many cases of incontinence, the cause of which cannot be discovered by the history, examination, or urinary analysis, the patients are relieved by symptomatic treatment.

In women cystocele is a frequent cause, in which case they are readily cured by an anterior colporrhaphy and repairing the perineum.

A prolapsed uterus should be suspended, and an anterior colporrhaphy or perineorrhaphy performed, if indicated.

There is no other condition in urinary diseases so trying to the patient as urinary incontinence; therefore, every means should be taken to discover and remove the cause. Cystoscopy should give us a clear idea of the condition of the bladder. If no cause is seen and if no disease of the nervous system is discovered, an exploratory laparotomy should be performed with the object of seeing if there is any interference with the bladder function from the outside. A large gynecological service leads me to believe that, in women, such interference is due to adhesions of the bladder to the neighboring structures, and that the consequent displacement and interfered function of the bladder is more common than was formerly supposed.

II. CHANGES IN THE AMOUNT OF URINE

Polyuria

The term polyuria indicates an increased secretion of urine and is a symptom, not a disease. There is, however, a form of polyuria which seems to exist independently of any other condition and is known as "essential polyuria" or polyuric diabetes.

The term polyuria is usually applied to cases in which the amount of urine exceeds two liters in twenty-four hours. It must be carefully distinguished from frequency of urination, because, as we have seen, the latter may exist with a normal amount of urine. The amount of urine for twenty-four hours should be accurately measured before making a diagnosis of polyuria. Malingering by the patient who may add water to his urine should be excluded.

Etiology.—Transient polyuria may exist from extraneous causes in health, and can usually be made out without difficulty, as in people who drink large

amounts of cold water and consequently have a polyuria of remarkable degree within a few hours. Warm enemas, and warm fluids drunk give rise to a polyuria. The same is true of a cold bath, while a hot bath diminishes the amount of urine secreted. The ingestion of diuretics and other therapeutic measures also transiently increases the urinary secretion. Other important causes of polyuria are sudden emotions, epileptic seizures, nervous strain, mental application occurring especially in those not accustomed to it, causing a polyuria which disappears as soon as the mental work is discontinued. This may be termed "nervous polyuria."

The polyuria of convalescence is another type of the transient form. This includes the increase in the amount of urine noted at the end of many diseases. The object of this is to rid the system of certain products which are excreted in large amount, as, for example, the chlorids in pneumonia.

A convenient division of the polyurias occurring from organic diseases is into the moderate polyuria, reaching up to four liters, and the marked polyurias, reaching as high as ten liters and over. The moderate type, according to Mercklen, indicates disease of the urinary organs, while the marked polyurias are seen in diabetes mellitus and diabetes insipidus.

The causes of polyuria may be thus tabulated, after Castaigne's description:

A. MODERATE POLYURIAS

I. *Due to Renal Disease.*
- (*a*) Chronic interstitial nephritis.
- (*b*) Amyloid kidney.
- (*c*) Reflex congestion of the kidney.
- (*d*) Pyelonephritis.
- (*e*) Tuberculous kidney.

II. *Due to Heart Disease.*
Permanent in persons with cardiosclerosis.

III. *Due to Liver Disease.*
Cirrhosis (sometimes).

IV. *Due to Nervous Causes.*
Hysteria.
Epilepsy.
Exophthalmic goiter.
Reflex from:
- Cerebral hemorrhage.
- Meningitis.
- Sclerosis of the cord.
- General paresis.
- Sciatica.
- Mental strain.

B. MARKED POLYURIAS

I. Glycosuria—diabetes mellitus.
II. Uricacidemia—nitrogenous diabetes.
III. Phosphaturia—phosphatic diabetes.
IV. Diabetes insipidus—hydruria.

The urologist is especially interested in the first group of polyurias, due to renal disease. Even if interstitial nephritis and amyloid kidney have been excluded, there may be a polyuria due to trouble further down in the urinary tract. The urethra, bladder, prostate and ureter should be examined to make sure of their integrity. Frequently strictures, chronic cystitis and hypertrophied prostate are reflex causes of a polyuria, or else the ascending infection to which they give rise produces a pyelonephritis and so gives rise to a polyuria. (See Table A, 1, *a*, *b*, *c* and *d*.) With the latter there will be purulent urine from the pelvis of the kidney on ureteral catheterization, while with the reflex form of polyuria in these conditions the urine will be clear.

Anuria

Definition.—The word anuria is derived from *an*, without, and *ouron*, urine. It means, therefore, literally a total absence of urinary secretion, although, clinically, we understand by anuria the absence of urine from the bladder, which is ascertained by the introduction of a catheter into this organ after the patient has failed to urinate for some time.

Etiology.—Anuria may be due either to an arrest of secretion of urine (nonobstructive anuria) or to an obstruction in the ureters (obstructive anuria).

A. Nonobstructive Anuria—A Suppression of Urine.—A cessation of the secretion of urine may be induced (1) by disease of the secretory apparatus of the kidney, (2) by circulatory disturbances affecting the renal circulation, (3) by certain nervous affections, or (4) by toxic agents.

(1) *Anuria due to lesions of the kidney* may occur in either acute or chronic nephritis. In acute nephritis due to scarlet fever or other causes, there may be suppression of urine due to a degeneration of the epithelium of the tubules, with or without involvement of the glomeruli. In chronic nephritis the kidney may become so atrophied and sclerosed that it no longer contains sufficient secretory elements to maintain the process of excretion. The anuria of chronic nephritis, however, is more frequently the result of a complicating passive congestion, or an edema of the interstitial tissue which so compresses the urinary tubules that secretion is arrested.

(2) *Anuria due to circulatory disturbances* is produced by a venous stasis in diseases of the heart, or else by large double infarcts of the kidney. In the

former type, the chief factor is the dilatation of the right ventricle, which produces venous stasis of the kidney. There is always a disease in the kidney in such cases, and the venous stasis suffices to produce edema of the interstitial tissue and thus to choke the tubules. Cases of double plugging of the ureters by desquamation, as in scarlet fever, or by suppuration products, in cases like nephritis, or of other origin are reported. Such cases must, however, be very rare, the lesion existing by far more commonly as unilateral.

(3) *Anuria due to nervous causes* may depend on a variety of conditions. Complete suppression of urine has been noted in some cases of hemiplegia from fracture of the skull. More frequently, however, anurias are due to reflex inhibition of secretion. It appears that an irritation in one kidney can so affect the other organ reflexly, that anuria may follow. Thus may be explained the anuria of renal colic, following operation upon the kidney or injury of that organ. Extensive burns may also produce reflex anuria, although the absorption of toxins may have something to do with these cases (Castaigne).

In hysteria, the anuria is probably also reflex, although the exciting cause is not always apparent.

(4) *Toxic anurias* may occur in the course of infectious diseases such as cholera, scarlet fever and in acute peritonitis and affections of the colon and small intestines. The toxins probably act by affecting the renal tissue, as well as by disturbing the circulation.

B. Obstructive Anurias.—The second group, the obstructive anurias, are of great interest to the modern surgeon, particularly because they can be remedied by timely intervention.

They result either from the blocking of the lumen of the ureter or from its compression or kinking. Among the obstructive causes we have, foremost, renal calculi. The mechanism and pathology of this form of anuria has been described in the chapters on calculus of the kidney and of the ureters, respectively. It has been said that it is not necessary to have a stone in both ureters, but that the presence of stone on one side often acts reflexly by inhibiting the secretion of the opposite kidney. This is a course of events which Guyon has described, but it is probably of rare occurrence. In most instances, the anuria due to stone on one side arises because the opposite kidney had not been working for some time, and when the calculous kidney, which alone was capable of excreting urine, was blocked, a total suppression of urine resulted. Albarran has gone so far as to say that calculous anurias may exist without the actual presence of a calculus in the ureter at the time when the symptoms occur.

Compression of the ureter may produce anuria in such conditions as cancer of the bladder, the prostate, the uterus or the kidney. Kinking of the ureter in floating kidney may be accompanied by obstructive retention on one side and arrest of secretion on the other.

Symptoms.—Anuria can exist for a long time without giving rise to any symptoms. It also occurs at times with astonishingly few symptoms. The phenomena of renal insufficiency and of uremic poisoning, which are described elsewhere under the heading of Uremia, come either slowly or suddenly, according to the type of uremia, acute or chronic, which develops as the result of the suppression of urine. Usually the first symptoms are gastro-intestinal in character, including nausea, anorexia, vomiting, eructations and either constipation or diarrhea. Headaches, restlessness and other nervous phenomena of uremia are also among the early symptoms. Patients with anuria may die within a few hours, showing the acute form of uremia in its most pronounced type. They may also live for days and even weeks without showing any acute symptoms and linger on toward a slow death with the manifestations of chronic uremic poisoning.

The occurrence of a nonfunctionating kidney on one side is more common than it is generally thought to be. I have occasionally seen such an organ, both larger and smaller than normal, due to some suppurative process, calculus, tuberculosis or some other cause, where the parenchyma had been destroyed and nothing but a sclerosed mass or shell remained. I have cut into such kidneys at operation and had little or no bleeding. In a case where such a kidney is present, if the remaining organ is suddenly incapacitated, an attack of anuria would occur.

Diagnosis.—It is comparatively easy to recognize the existence of anuria by passing a urethral catheter, which at once differentiates this condition from retention. The important point, however, is to determine the cause. The first thing to do, if possible, is to determine the presence and seat of the obstruction. This may be done by palpation and by ureteral catheterization. The presence of obstruction will at once suggest the treatment of the condition.

If the anuria be transient it may be preceded by or accompanied with a clinical picture of renal colic; or there may be a history of traumatism, or of an operation either on the abdominal organs or upon the kidney.

If the anuria is more or less permanent, we should first exclude the presence of chronic diseases, such as affections of the kidney or of the heart or of acute infectious or toxic conditions. If the anuria comes on suddenly, it is usually due to calculi, though hysterical anuria should not be lost sight of.

A word should be said of the hysterical type of anuria. Usually the patient presents some of the peculiarities or stigmata of hysteria. Charcot noted also a certain compensation between the anuria and the vomiting which seemed to alternate; thus, when the patient, who was a woman, urinated 3 grams of urine, she had 1 liter of vomitus. When the urine increased to 206 grams, she vomited only 362 grams. Hysterical anuria is a tissue anuria and not glandu-

lar. In other words, there is a more or less complete suspension of the proteid katabolic function of the digestive epithelium of the organism. A very interesting and rather puzzling feature of these cases is that hysterical subjects may have anuria for a number of days or even for several weeks without showing any uremic symptoms whatever.

Treatment.—The medical treatment of anuria is the same as that described elsewhere under the heading of Uremia.

Treatment of Obstructive Anurias.—In case the history of anuria points to a surgical cause—such as an attack of renal colic on the one side, the passing of calculi, pain in the loin on one side for a considerable time, a purulent urine without symptoms of frequency, or a hematuria following exertion—the case should be immediately examined, not only by palpation, but also by cystoscopy and catheterization of the ureters. If one ureter is found obstructed, even though the other catheter enters the kidney, an incision should be made in the loin of the obstructed side, a nephrotomy performed, the pelvis examined and a catheter passed down the ureter to the seat of obstruction. The kidney should then be drained and the treatment of the ureteral obstruction postponed until the patient has recovered from the attack of anuria, in case this temporary operation is successful.

The result of the hemorrhage accompanying the operation will benefit the patient the same as bleeding in uremia, and saline solutions can be given by the rectum, or into the tissues or a vein, as indicated.

Oliguria

Oliguria, or diminution in quantity of urine, is noted in a variety of pathological conditions, affecting either the urinary tract or the general system. Temporary diminution is noted in health, and should be carefully distinguished from true oliguria. This term should not be employed unless the change in the amount of urine is well marked and continues for several days, and unless all extraneous causes can be excluded.

The conditions under which the urine is diminished in quantity in health have already been considered under the heading of Urine Analysis. They are briefly: Exercise, free perspiration and not drinking sufficient water. In disease the urine is diminished in acute nephritis, especially after scarlet fever. in acute congestion of the kidney, in the acute stages of chronic nephritis and often in the last stages of chronic nephritis, accompanied by uremia. The urine is also diminished in conditions of stasis of the kidney due to heart disease. Among the general conditions which produce oliguria and which are important to the urologist, are shock after anesthesia or after operations on the genitourinary organs. Oliguria is also noted in fevers, where it is accompanied by a concentration of the urine. Other causes of oliguria are prolonged diarrhea

and vomiting, such as occurs in some diseases as cholera or yellow fever. The urine is markedly diminished in quantity in all diseases in the last stages before death.

III. CHANGES IN THE CHARACTER OF THE URINE

Hematuria

Definition.—Hematuria means the admixture of blood in the voided urine, no matter from what source the blood is derived. Clinically, the term is applied only to cases in which the amount of blood is such as to be perceptible to the naked eye on inspection. The presence of a microscopic amount of blood is not clinically styled hematuria.

Hematuria must be carefully distinguished from hemoglobinuria. The latter means the direct passage of the blood-coloring matter into the urine without any red blood corpuscles, the urine being acid and of lower specific gravity than in hematuria.

Etiology.—The causes of hematuria are many, the determination of which is one of the most important procedures in the clinical study of urinary diseases. The etiologic factors may thus be briefly summarized:

Etiology of Hematuria

(Tabulated after Castaigne with Modification)

I. *Traumatic Hematuria.*

(*a*) *Wounds and Injuries of Any Part of the Tract.*

(1) Urethra { Rupture. / Urethrotomy. / Fracture of pubis.

(2) Bladder { Wounds. / Injuries to pelvis.

(3) Kidney { Wounds. / Injuries to loin.

(*b*) *Stone in Any Part of the Tract: Foreign Bodies.*

Pelvis of kidney; ureter.
Bladder.
Posterior urethra.

(*c*) *Sudden Change of Pressure in Bladder.*

When a bladder is emptied too suddenly or too completely, in a case of retention, we may have bleeding from the bladder or even from the kidneys, due to congestion.

II. *Inflammatory Hematuria.*
- Anterior urethritis.
- Posterior urethritis.
- Cystitis.
- Pyelitis, acute.
  - Acute nephritis.
  - Hemorrhagic nephritis.
  - Chronic nephritis. Some types in which vessels are changed.

III. *Due to Tumors.*
- (1) Prostate.
- (2) Bladder.
- (3) Kidney.

IV. *Due to Tuberculosis.*
- (1) Prostate.
- (2) Bladder.
- (3) Kidney.

V. *Due to Parasites.*
- Renal parasites; Bilharzia; Filaria, etc.

VI. *Due to General Changes in the Blood.*

Smallpox	Yellow fever	Hemophilia
Typhoid	Plague	Leukemia
Purpura	Phosphorus poisoning	Malaria

Detection of Hematuria.—This has been considered in the chapter on The Urine, so far as chemical and microscopic tests are concerned, but there are certain gross characteristics to hematuria which aid in its detection and localization.

If bloody urine is allowed to stand for a little while, it deposits a more or less abundant sediment. Over this there remains a clearer, but still cloudy, fluid. This may be bright red in color, showing that the blood has been freshly shed and that it probably comes from the lower part of the tract—from the bladder usually. The amount of blood will determine in such cases the exact tinge. The more dilute the bleeding, the paler the tint, but fresh blood is always red.

Renal hematuria is characterized by a pale, reddish-brown, cloudy urine, the sediment containing no clots, unless they are wormlike casts of the ureters. If retained for a long time in the pelvis or in the bladder, in hematurias associated with obstruction, there may be a dark-brown or even black color to the fluid.

The *sediment* of bloody urine varies in amount, color and consistency. The

first thing that strikes one is the presence or absence of clots. When the bleeding is from the kidney or ureters, the *clots* sometimes assume the appearance of dark-red wormlike masses.

Next to clots, the urine may sometimes contain a *bloody sediment* mixed with fragments or masses of tumors. These may be fibrinous or shaggy, or they may appear more regular, villous. The deposit may, of course, be also mixed with fragments of crystalline substance, particles of calculi, etc.

When, as very often happens, the blood is mixed with pus, the deposit assumes peculiar stratifications. In some cases, the deposit of yellowish-gray pus is arranged in strata separated by bright-red streaks. This means that a layer of pus alternates with a layer of blood cells. In other cases, the purulent (usually muco-purulent) sediment is thick, glairy and tenacious, and is tinged a distinct red color. These are cases of alkaline urines, in which pus has undergone the glairy change into a viscid mass, as the result of the action of the alkali. In these cases, the urine itself is but feebly tinged. There is finally another class of cases in which the urine is bright red and the sediment is grayish or gelatinous. These are usually cases of cystitis, prostatic abscess, or other purulent infection of the tract, in which a fresh hemorrhage has taken place as the result of some existing cause.

Diagnosis of the Cause.—The diagnosis of the cause of a hematuria is very important and often a puzzling problem. The question is easily solved when there is a blood disease manifesting itself in other hemorrhages, as in purpura; when the urine shows signs of acute nephritis, oliguria, high specific gravity, albumin, casts, etc.

Hematurias due to stone are often characterized by an intermittence or a remittence; they may be accompanied by pain, and are worse after any form of exertion or jarring motion, while hematurias due to tumor and to tuberculosis usually occur independent of either pain, exertion or jarring.

To sum up:—The cause of hematuria must be determined after a careful study of the history of the case, a thorough examination of the patient and a complete analysis of the urine. If these precautions are taken, one will seldom err in determining the pathological process which gives rise to the bleeding.

Localization of the Bleeding.—Bleeding from the Urethra.—When there is bleeding from the anterior urethra the blood oozes or drips from the meatus independently of micturition. But when the blood is beyond the cut-off muscles, the blood does not ooze from the meatus, but is voided with the urine. The two-glass test shows blood in both glasses, the second more than the first, because the muscular effort of expulsion brings out any residue of blood that may be present in the posterior urethra.

Bleeding from the Prostate.—Bleeding from the prostate is also characterized by the same features. In bleeding, either from the prostate or the prostatic urethra, the bladder urine may also be bloody, owing to the regurgi-

tation of the blood into the bladder. The differential diagnosis will depend on age, history, clinical and urinary examination. By washing the bladder through a soft-rubber catheter until it is clean and then filling it with water, if the fluid escaping through the instrument is free from blood while the remainder voided is mixed with blood, the source of the hemorrhage is below the vesical sphincter.

Hemorrhage from the Bladder.—Hemorrhage from the bladder, if profuse, gives a red color to the urine, although, if collected in three glasses, the last glass will contain the most blood. If the bladder is washed clean by catheter and the instrument is allowed to remain in place for a short time, the bladder contents will again become bloody. At times, the last drops alone contain fresh blood. Cystoscopy will usually show us the source of the bleeding if there is a bleeding point in the bladder or if it comes from one or both ureters.

Bleeding from the Ureter.—Bleeding from the ureter is characterized by the elongated clots already described, unless it comes from the vesical end close to the bladder.

Bleeding from the Kidney.—Bleeding from the kidney is diagnosed by excluding all other sources. The blood is thoroughly mixed with the urine in these cases and there is no separate quantity of fresh blood, as in the hemorrhage farther down. In the three-glass test, the patient voids a uniformly tinged urine in all three cases. Microscopically, in renal hematuria, we have blood casts and renal epithelia, besides the fact that the red blood cells "are washed" out and appear as swollen shadow disks scarcely perceptible.

Having located the bleeding in the kidney, we must next try to find out the cause of the symptom. In *stone*, we have the history of colic, the aggravation of the bleeding after exertion or jarring, and the subsidence of it after days of perfect rest, while fragments of crystalline masses in the urine will often clinch the diagnosis.

In *tumor of the kidney,* we have bleeding which appears and disappears without apparent cause; emaciation; a tumor in the loin; increasing pain; a feeling of weight; and symptoms of pressure and a varicocele when on the left side. Cancer cells and tumor fragments in the urine would complete the diagnosis.

In *tuberculous kidney*, a polyuria is very suggestive. When it is accompanied by renal hematuria, the bleeding recurs without apparent cause. Tubercle bacilli may sometimes be found in the sediment. It is difficult, however, to assign a definite cause for the early hematurias which come in renal tuberculosis before any marked changes have occurred in the kidneys.

In *nephritis,* large numbers of red blood cells always indicate the acuteness of the condition. In some cases, renal bleeding occurs without previous signs of acute or chronic nephritis. (Perhaps the term "essential hematurias" is justified, but in all probability there is some basis for the occurrence of the bleeding.) Thus a number of cases have been found, after nephrectomy, to be

early stages of renal tuberculosis, and in certain cases there were found the signs of a chronic interstitial nephritis with arterial changes. Castaigne emphasizes the value of studying the arterial tension in such cases. If the tension is high, we may suspect the presence of interstitial changes in the kidney in cases of otherwise unexplainable bleeding. The presence of even slight uremic symptoms point to interstitial nephritis rather than to other causes of renal bleeding.

Which of the two kidneys is bleeding is usually determined nowadays by cystoscopy and watching the urine coming from the ureters, and also by ureteral catheterization.

ORDER OF FREQUENCY OF CAUSES OF HEMATURIA

In the Clinic.	*In the Hospital.*
Stricture.	Stone in bladder.
Prostatitis.	Stone in kidney.
Renal calculus.	Tuberculous bladder.
Tuberculous cystitis.	Tuberculous kidney.
Tumor of bladder.	Tumor of bladder.
Prostatic hypertrophy.	Stricture.
Nephritis.	Prostatic hypertrophy.
Ulcer of bladder.	Rupture of kidney.
Carcinoma of prostate.	Retention of urine.
Seminal vesiculitis.	Nephritis.

These two lists simply show the order of frequency in my clinic and hospital. The causes would have been very different if taken from other hospitals with which I am connected.

Pyuria

Pyuria means pus in the urine from whatever source. Pyuria may be due to any suppurative inflammation in the urinary tract, or to a suppuration in some communicating or adjoining organ. It is one of the most frequent symptoms encountered in urological practice.

We must always satisfy ourselves that pus is actually present and that we are not mistaking anything else for it, for urine passed as a cloudy fluid may be free from pus, the cloudiness being due to either mucus, bacteria, phosphates or urates.

Differential Diagnosis.—Every practitioner, therefore, should be familiar with the rough clinical tests which are necessary to determine the presence of pus immediately after the urine has been passed.

Mucus.—Normally a faint mucous cloud, which very slowly settles, is present in the urine. It consists of mucus mixed with a few epithelial cells from the bladder. It is much more pronounced in women, on account of the admix-

ture of vaginal mucus. It is markedly increased in catarrhal conditions of the urinary tract, especially in cystitis, prostatitis and urethritis.

A rough test for mucin, which is the proteid substance contained in the mucous cloud, consists in diluting the urine with equal parts of water and adding acetic acid, until a precipitate of mucin is formed which is soluble in an excess of acetic acid. As a general rule mucus may be distinguished from pus in the urine by the fact that it floats longer, is less dense and more evanescent than pus.

Phosphates.—Phosphates, when present in excess, or when the urine is slightly alkaline, create a diffuse turbidity, which gradually settles on standing. A few drops of acetic acid added to such a urine will almost immediately clear it up, while, if the turbidity be due to the presence of pus or mucus, it would be increased by the addition of the acid.

Bacteria.—Bacteria, when growing in large numbers in the urine (see Bacteriuria), give rise to a faint cloud which has a tendency to float in the middle part of the vessel. This cloud remains practically unchanged by the addition of acetic acid.

Urates.—Urates, when present in excess, form a turbidity which rather rapidly deposits as a sediment. The lower the temperature of the urine and the greater the acidity (within certain limits), the more apt are urates to precipitate. Simply heating a test-tube containing such a urine gently over the flame will dissolve the turbidity and clear the urine. If pus were present heat would increase the turbidity instead of decreasing it.

Chyluria.—Chyluria may be mistaken for pyuria. In this condition the urine is milky, yellowish-white and shows a film of fat on standing. On shaking with ether, the fat is dissolved and the urine becomes normal in appearance.

Pus.—Pus in the urine is characterized usually by a cloudy appearance immediately after passing. The cloudiness is usually in proportion to the amount of pus. Small amounts of pus may be present in the form of clumps or shreds, the urine remaining comparatively clear at the time of passing.

There is not much difference in the appearance of purulent urines according to the locality of the affection. Urine, clear or slightly turbid, with thick threads, points to the urethra; urine which is thick and turbid and tends to become gelatinous on standing, points to the bladder; urine which is opaque and not thick, but with pus held in suspension, points to the kidney. If it is of a light color, a lemonade or even whiter, it is probably from a tubercular organ, while if it is darkly colored, it points more to a calculous kidney. The light-colored pyuric urine usually occurs when there is considerable polyuria with pus and points to a pus kidney, the darker when the urine is more concentrated or bloody.

The color of the urine is not much affected by the presence of pus, unless

there is a large amount, in which case it appears whitish-yellow in color and, in decomposing, urine will assume a dirty gray tint.

The odor of purulent urine may be either normal, when the urine has retained its normal acidity, or it may be extremely offensive, putrescent or ammoniacal, or, in still other cases, slightly resemble that of hydrogen sulphid. Putrid urine occurs principally when there is decomposing residual urine in the bladder or kidney.

The reaction of purulent urine varies greatly, according to the amount of decomposition which the urea undergoes in each particular case. There is no specific connection between the reaction and the localization of the trouble. Formerly it was believed that when the purulent urine was alkaline or ammoniacal, we had to deal with a cystitis, while if it were acid, a pyelitis or pyelonephritis was present. Further advances in urology, however, have shown that ammoniacal urine may be obtained with the ureteral catheter from the pelvis of the kidney.

When purulent urine undergoes alkaline fermentation, the pus coagulates into gelatinous masses which adhere to the bottom of the vessel.

Donné's Test for Pus.—This is a rough clinical test which is of great aid to the practitioner in distinguishing pus from mucus and other sources of cloudiness. It consists in allowing the sediment to gravitate to the bottom of a conical glass, pouring off the urine which floats over the sediment, and adding the ordinary solution of caustic potash (potassium hydrate), drop by drop, until the gelatinous tenacious mass mentioned above is formed, adhering to the bottom of the vessel and slipping out of it *en masse*.

Localization.—Having satisfied ourselves that pyuria is present, the next step is to determine its source. This we do in several ways. First, we apply all the special methods of clinical examination which may have a bearing upon the localization of the trouble. The history of the case and the general physical examination, including rectal palpation, examination of the urethra, of the bladder and of the ureters through the catheterizing cystoscope, are all methods which have been described elsewhere and which must be called into play at times in determining the source.

Before we proceed to the special methods, however, a few simple clinical tests should be applied which will often give us a fair idea of the location of the pus:

Thus, if we can express it from the meatus, the pus is evidently urethral and, in man, probably comes from the anterior urethra. Next, if we apply the two-glass test and the first urine contains pus and shreds, and the second portion, passed immediately afterwards, is clear, it is evident that the discharge is of urethral origin. If the first and second urines are both cloudy, it shows either that the posterior urethra, in the male, is so acutely involved that some of the pus overflows into the bladder, or, what is more prob-

able, that there is an involvement of the urinary tract above the vesical sphincter.

When the whole amount of urine passed is found to contain pus, there is no doubt that some affection exists, at least as high up as the bladder, if not higher. When this is found to be the case, the special methods, such as cystoscopy, catheterization of the ureters, etc., may be applied, in order to localize the trouble.

Considerable information, however, may be gained regarding the case and a probable diagnosis may be made, from a detailed urinary examination in cases of pyuria, provided this examination is made by an expert in this line of work. I want to emphasize strongly the need, particularly in these cases, of confining urinary examinations to none but competent men, of whom there are comparatively few, even in our larger cities.

Attempts have been made to determine the amount of pus in the urinary sediment by counting the number of pus cells (Goldberg, Posner). This method is faulty, because the pus is generally very unevenly distributed in the urines and often occurs in clumps or masses. It is determined with sufficient accuracy by centrifugation of the acidified urine, still warm (after heating it to assure the solution of other sediment), in a tube graduated in cubic centimeters. When the urine contains much pus, the sample must be correspondingly diluted, before centrifugation, with much saline solution.

There is no way of telling, from a study of the pus cells found in the urine, the locality from which they come. The clew to the localization of the suppurative processes occurring in the genito-urinary tract, is chiefly the study of the epithelial cells that accompany them, and, secondarily, the study of casts and blood corpuscles. Although it is true that there are always some cells in a urinary sediment whose exact origin is somewhat doubtful, the majority of epithelia can be located with fair accuracy and a trained observer can differentiate the epithelial cells of the kidney from those of the pelvis, the ureter, the bladder, the prostate and the urethra.

When the bladder alone is involved, we find epithelial cells from the various layers of the mucosa of that organ according to the depth of the lesions. In ordinary cystitis, the cells from the superficial and middle layers only are present. When there is ulceration, the deeper layers add their quota of cells.

When pyelitis is present, whether due to infection, stone, tuberculosis or tumor, a considerable number of pelvic epithelia will accompany the pus.

If there is also a large number of cells from the bladder, a coincident cystitis exists, which may have been the primary affection.

When the kidney is involved in the suppurative process, there are in the purulent sediment many epithelial cells from the renal convoluted tubules or from the straight collecting tubules. If there are at the same time granular, epithelial, pus or blood casts, we are dealing with a suppurative nephritis. If,

in addition to all these, there are many cells from the renal pelvis, we have to deal with a pyelo-nephritis.

If the pyuria is intermittent or remittent, we must think of the presence of pyonephrosis with intermittent obstruction of the ureter, as stones, or a pyonephrosis in movable kidney.

It must be understood that these diagnoses are based on the recognition of a considerable number of pus cells and a large number of epithelia from some region of the urinary tract. When only a few pus cells and a few epithelia are present, we are probably dealing with a nonsuppurative condition or merely with a congestion or irritation along the tract.

Next to the presence of epithelia, the occurrence of casts is important in the urinary analysis, as it speaks for the involvement of the kidney. The kidneys may participate in the suppurative process or they may be the seat of a secondary nephritis of the nonsuppurative type, or both; in either case, casts may be present. Whenever there are pus casts, that is, casts of any type which are studded with pus cells, renal suppuration may be diagnosticated with a reasonable degree of certainty. It must be remembered, however, that casts are not always found in suppurative nephritis, any more than they are in the nonsuppurative types of nephritis. Their absence, therefore, does not necessarily exclude the presence of suppurative nephritis, provided that pus and renal epithelia are present in sufficient quantities.

The size of the casts varies according to the region of the kidney involved and something may be known of the extent of the process from this feature. When pus casts of large diameters are found, we know that the nephritis has involved the medullary portion. Casts from the narrow part of the tubules are smaller in diameter, next come the casts derived from the convoluted tubules, and finally the casts from the straight collecting tubules. When the smaller casts from the convoluted tubules have pus cells imbedded in them, we know that the cortex has been reached by the affection. Larger-sized plugs of pus from the calices are found sometimes in pyelitis.

Connective-tissue shreds when present in the urine, accompanied by epithelia and pus, show that there is some destructive process in the urinary tract. When the epithelia are renal and the sediment also contains pus casts, the presence of connective-tissue shreds is indicative of destructive processes in the kidney.

Having thus localized the pyuria, some further points in the urinary examination may often give us a clew as to the cause of the suppuration. Thus, if stone be the cause, the unusual abundance of some form of crystals or the occurrence of crystals in solid masses may suggest the presence of a calculus.

If tubercle bacilli, gonococci or other microörganisms are found in the sediment, we have the bacteriological clew to the pyuria. If portions of tumors, such as papillomas or malignant growths, are found, a correct diagnosis may

sometimes be made from the urine. Unfortunately, these tumor fragments are not frequently encountered.

Having considered the urinary report in detail and compared it with the history of the case and the findings of the physical examination, we can determine that a suppurative condition exists somewhere in the urinary tract, that it is probably due to either obstruction, stone, tumor, or tuberculosis, with infection. If the urethra is involved, it may be detected by instruments; if the prostate, it may be felt; if the bladder, it may be seen by the cystoscope; if the ureter, it can be felt by the catheter; if the kidney or pelvis, the ureteral catheters will reveal the condition and the side involved, by the character of urine draining from the ureter.

Pneumaturia

The term pneumaturia is applied to the evacuation of free gases in the urine. The gases are formed in the bladder, or they may enter the organ through recto-vesical and vesico-sigmoidal fistulas.

According to Guiard, the production of CO_2 in the bladder as a result of alcoholic fermentation in glycosuric urine is one source of pneumaturia. Miller and Senator analyzed the escaping gas in such a case and found it to consist of hydrogen and carbon dioxid. The production of this fermentation in the bladders of diabetics may be due to a cystitis produced by Bacillus coli infection (Schnitzler).

When a cystitis is due to the growth of gas-forming bacteria, such as the Proteus vulgaris and allied forms, there may be a pneumaturia, although the urine is free from sugar. Heyse and Favre each found the Bacillus lactis aerogenes in a case of pneumaturic cystitis without glycosuria.

The gas bubbles are usually expelled with the last portions of urine. If there is retention, the gases may accumulate and give rise to a false sense of vesical emptiness owing to a tympanitic resonance over the bladder. In diabetic urine, the reaction, even after this fermentation, is acid; in other urines, pneumaturic fermentation is accompanied by alkalinity. The external features of the urine are the same as in cystitis, or in bacteriuria, as the case may be.

Gas bubbles have been found at autopsy in the renal pelvis, and the walls of the bladder have been found the seat of emphysema in several instances.

Bacteriuria

Bacteriuria is a condition in which there is an abundant growth of pathogenic germs in the urine, but in which there is very little evidence of an inflammatory condition of the urinary tract. Bacteriuria is generally thought to be associated with some lesion along the urinary tract.

Robert, in 1881 (*Brit. Med. Jour.*, 1881, 11, p. 623), was the first to

describe it. Since then a number of investigators, notably Krogius, Rovsing, Jeanbrau, Keyes and others have studied this condition.

Pathology.—The freshly voided urine in bacteriuria contains large masses of bacteria. The urine is cloudy, sometimes opalescent, and the cloud does not settle, but on shaking assumes wavy motions (Zuckerkandl). If there is a complicating urethritis or prostatitis, the first or second glass may also contain pus or shreds, but often the glasses contain nothing but the cloud described. No albumin is necessarily present, but the reaction for mucin with acetic acid is obtainable. The urine is acid in reaction and has a foul, fecal, rather than an ammoniacal odor. The microscope reveals large masses of bacteria, a few epithelia and still fewer pus cells or leucocytes.

The most common germ found in bacteriuria is the colon bacillus (in 83.5 of 67 cases reported by Jeanbrau), with or without some associated staphylococci (Barlow). Less frequently are found the streptococci, the proteus of Hauser, the Bacillus lactis aerogenes and the hydrogen-sulphid-forming bacteria (Rosenheim and Guzman; Karplus, quoted by Zuckerkandl). The typhoid bacillus which, according to Richardson and Gwyn, produces bacteriuria in twenty to thirty per cent of typhoid-fever patients, must also be included in this group.

In most cases, the infection is hematogenous or at least descending, from the kidney and the pelvis.

The line of distinction between a bacteriuria with a few pus cells and many bacteria and a mild inflammation of some part of the urinary tract with a few more pus cells and less bacteria is often perplexing to the practitioner. The question as to whether parietal lesions in the urinary tract are needed for the development of bacteriuria is still disputed. Most authorities say that such lesions always exist and that the mere presence of bacteria in the urinary tract does not cause bacteriuria, as has been shown experimentally by the injection of bacteria into the tract. They claim that besides these injections a parietal lesion must be made before a bacteriuria develops.

The parietal lesion in bacteriuria is not in the bladder. It is sometimes in the prostate. Krogius, Hogge, Goldenberg, Gassman, Keyes and the author have observed such cases. It is usually situated in the ureter, the kidney and its pelvis, although the lesion may be unrecognizable clinically. It may be due to typhoid infection, to the puerperal state, or to prostatic hypertrophy. Exceptionally bacteriuria is said to be due to prostatitis and vesiculitis.

Symptoms.—Certain local and general symptoms have been ascribed to bacteriuria. The general symptoms may be due to the colon infection, which is so often present in these cases. They are lassitude, headaches, anorexia, intestinal disturbances and at times a febrile movement. Locally, there may be the symptoms of a chronic urethritis, pyelitis, prostatitis, vesiculitis, etc.

Treatment.—The treatment consists in the removal of the cause and the administration of hexamethylenamin (urotropin) in doses of seven and a half to ten grains three times daily. Local treatment by lavage of the ureters and pelvis, by washing the bladder and posterior urethra and by massaging the prostate and vesicles, is also indicated according to the source of the trouble.

CHAPTER XII

URINARY FEVER (CATHETER FEVER), URINARY INFECTION

The older authors, among them Velpeau, Civiale and Thompson, spoke of urinary fever or catheter fever as a form of natural reaction of the body to the shock or irritation induced by the introduction of instruments into the urinary tract. It was thought by some that the phenomena of urinary fever which were chiefly characterized by a chill, fever and sweating were of nervous origin. This was the theory of Von Dittel, who regarded the febrile paroxysm as a reflex process induced by the irritation of the nerves of the urethra. Velpeau regarded catheter fever as a form of systemic poisoning, in virtue of the entrance of urine into the system through some minute injury resulting from the instrumental interference. Thompson distinguished catheter fever, which he divided into acute and chronic, from urinary infection proper, which he styled pyemic or septicemic fever. The idea that the fever following urethral instrumentation was of nervous origin, held sway until light began to dawn under the influence of the work of Oliver Wendell Holmes and Semmelweiss on puerperal fever and of the discoveries of Pasteur, Lister and Koch.

The modern definition of urinary fever, or catheter fever, makes it synonymous with urinary infection, and regards it as always due to the entrance of germs or their toxins into the blood. The normal urine in a healthy bladder is aseptic and, in the absence of a urinary or general infection, the urine withdrawn after death has been repeatedly shown to be sterile. Bacteria become lodged with difficulty in the normal bladder under healthy conditions. When there are certain predisposing causes, however, such as congestion, injury to the wall, or retention of urine, bacteria may multiply very rapidly.

The routes which infection may take from the urinary tract into the circulation are numerous, as have been shown by experiments on animals and by a study of numerous autopsies. Thus, it has been shown that, under favorable conditions, germs injected into the bladder can pass through the mucous membrane into the blood and kill the animals through a general infection without necessarily ascending to the kidney. In some instances, the infection in the blood penetrated into the kidneys and septic foci were found in the latter organs, although the ureters and pelves of the kidneys remained free.

The urethra may also be a portal of entrance for a general infection, espe-

cially after instrumental interference. It has been shown experimentally that bacteria could be found in the blood five hours after the introduction of an instrument through a stricture. Bartelsmann and Mau (*Münchener medizinische Wochenschrift*, 1902, p. 21, quoted by Zuckerkandl, *loc. cit.*) showed that in a case in which a stricture was sounded and the instrumentation was followed by chills, staphylococci were present in the blood during the chill and the same variety of bacteria were found in the urine.

A point to be remembered in connection with urinary infection is, that even when instruments are sterile there may be vesical infection through carrying bacteria, which are always abundant in the urethra, into the bladder (Melchior). In women in whom the urethra is wide and short, there may even be spontaneous infection of the bladder from the healthy urethra, the germs presumably coming from the vulva.

In addition to this, we must remember that there are two other ways in which germs can enter into the urinary tract. One is through the kidneys from the blood, and the other through the intestinal tract. It has been quite thoroughly established by experiments (Biedl and Kraus, quoted by the latter in Frisch and Zuckerkandl's "Handbuch der Urologie," vol. 1, p. 444), that it is not necessary to have a lesion in the kidney in order to have bacteria pass through this organ from the blood into the urine. Biedl and Kraus injected bacteria into the blood (Staphylococcus aureus, Bacterium coli, anthrax) and recovered them within an hour from the urine, although the latter contained no blood nor albumin and the kidney was perfectly healthy. Wyssokowitsch and others deny the possibility of bacteria passing through the healthy kidney, but it is probable that the investigations of Biedl and Kraus, which have been confirmed by several other observers, represent the actual conditions. A lesion may make it more easy for bacteria to enter the urine, but its presence does not seem to be absolutely necessary.

Bacteria can pass through an injured intestine into adjacent portions of the urinary tract, and recent investigations have shown that very slight lesions are sufficient to allow the Bacterium coli to pass through the intestinal wall and enter the urinary tract. Some authors have even gone so far as to say that this transference can go on with a normal intestine, while others, as Kraus, say it is probable that no bacteria can pass through the normal intestine, and Markus and Faltin (quoted by Kraus) found that constipation, produced artificially by closing the anus, was not sufficient to give rise to a passage of bacteria from the intestine into the blood. It is quite generally believed, however, that the bacteria from the intestine may in constipation either pass into the blood and thence into the kidneys and the bladder, or, if the constipation is very chronic and especially if lesions exist in the intestine, they pass directly into the bladder from the gut.

Having thus briefly discussed the modes in which infection penetrates into

the urinary tract, we now turn to the exciters of infection which need only be mentioned briefly here, as they have been considered in detail in the chapter on The Bacteriology of the Urine. The germs which are concerned in urinary infection are the same as those found more or less frequently in pathological urine. They are the Staphylococcus pyogenes aureus, albus and citreus; the Streptococcus pyogenes; the Urobacillus liquefaciens septicus; the Bacillus pyocyaneus and the Bacterium coli commune. The last-named is the most frequently responsible for urinary infection, while the staphylococcus and streptococcus come next in frequency. As regards the gonococcus, this germ itself is really not considered responsible for urinary infection as such and, in complicated cases of urethritis, in which urinary infection occurs, the latter is usually due to the associated secondary germs, although some instances of general infection with the gonococcus have been reported in which the patients died of peritonitis, septic endocarditis, etc., due to gonococcus infection (Jullien, "La Blennorrhagie," Paris, 1906).

Clinical Types of Urinary Fever.—The clinical forms of urinary fever may be considered under two general headings, the acute and the chronic types. The acute form, however, may be clinically subdivided into the single acute paroxysm and the acute prolonged or intermittent form.

Acute Type of Urinary Fever.—The acute paroxysm of urinary infection is the clinical type which the older authors knew as catheter fever. It is a type which is most distinctly referable to a true blood infection, as it is here that microörganisms have been most often found in the circulation both in the fulminating, rapidly fatal cases, and in the acute cases followed by recovery.

The acute paroxysm occurs either without warning or after the introduction of an instrument. The time which elapses between the instrumentation and the appearance of the first symptom varies between several hours and several days, but is usually a few hours. The first symptom is a severe chill, the patient having cold extremities, and a pale and cyanotic look. The chill varies in duration and severity, lasting from a few minutes to a few hours and may cause the patient's teeth to chatter, although usually it is not so severe and there is simply a chilly sensation. The respiration may be irregular, but as the chill wanes the breathing once more becomes regular.

The next symptom is the fever, which rises rapidly with frequent and tense pulse, rapid respiration and flushing of the skin, the latter being hot and dry. The rise of temperature reaches often to 105° F. or more and drops quite rapidly. The fever in a typical case is followed by sweating, beginning with a slight moisture and passing into a profuse perspiration. After the sweating, the patient complains of fatigue, headache and slight stiffness of the limbs.

In some cases, there are also during the attack delirium, diarrhea, vomiting and dyspnea. The delirium may accompany the chill and need not be regarded as important at this stage. The mouth and tongue are dry, especially when the

attack is a repetition of a preceding one. There may be bilious vomiting and later copious fetid stools. During the attack, the frequency of respiration may be accompanied by a sense of oppression constituting dyspnea. The pulse is usually irregular, if the infection is severe.

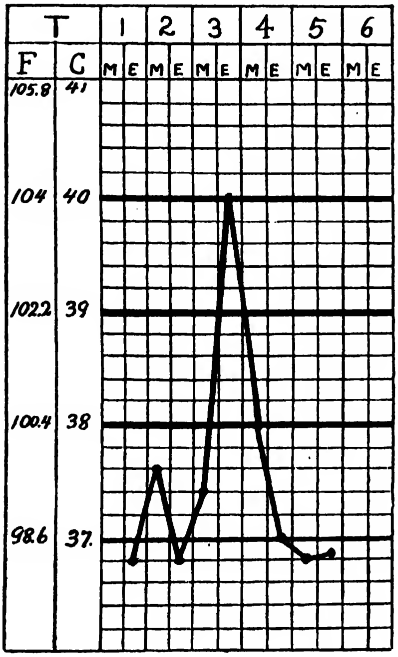


Fig. 227.—Acute Urinary Fever after an Internal Urethrotomy. (After Guyon.) These recur occasionally after passing sounds.

The single acute attack just described frequently passes away in a few hours, but it may last two or three days. Usually the shorter the attack the more severe it is, but these single attacks are rarely fatal. Deaths have, however, been reported following a chill which resulted from such a slight procedure as catheterization of a strictured urethra. In these fatal cases, the chill is prolonged and is followed by collapse, involuntary defecation, hiccough and gradual loss of consciousness.

It is scarcely necessary to refer to the great similarity between these single acute attacks and acute malarial paroxysms. The resemblance is made still more marked by the fact that the acute attack may be repeated after an intermission. The interval which is free from fever is variable in duration and the number of attacks also varies. Some authors claim that an atypical first acute attack, in which the stages of chill, fever and sweating do not succeed each other regularly, predicts an intermittent form with repeated attacks; but this rule is not to be relied upon, as frequently the acute attacks described above do not run their set course.

In the intervals, the patients may suffer from weakness, irregular pulse, loss of appetite and sleep, or they may feel perfectly well.

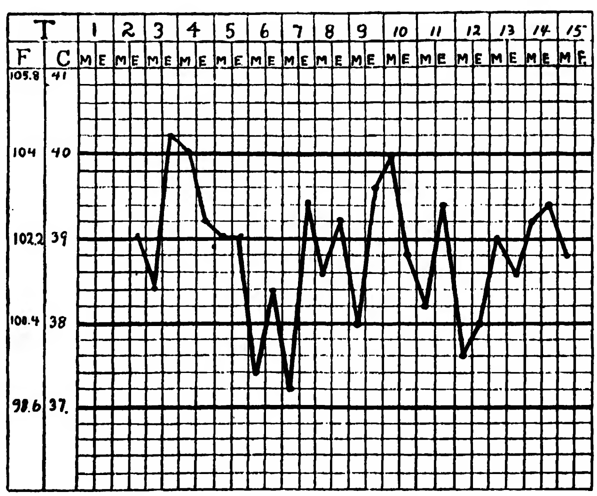


Fig. 228.—Acute Recurring Urinary Fever. Pyelo-nephritis revealed at autopsy. (After Guyon.)

The acute attacks may also assume the remittent form in which the fever is more or less continuous with acute exacerbations accompanied by chills. These are severe cases, as a rule, with some of the following symptoms: The temperature high, with delirium, prostration and loss of consciousness, with a dry tongue, a rapid and frequent pulse, vomiting, hiccough and symptoms of broncho-pneumonia. Pustular eruptions, purpuric patches and rashes resembling erythema nodosum sometimes occur. In some instances, the affection assumes a pyemic form with suppurations in the muscles, joints, cellular tissue, etc. The parotid sometimes becomes inflamed, showing that the urinary infection has involved the general system. All these local suppurations are extreme, and personally I have never seen an involvement of the parotid.

The prognosis in the prolonged, acute type, including both intermittent and remittent varieties, should be more guarded than in the primary acute form. Usually, recovery sets in from one to three weeks after the first paroxysm, with a gradual defervescence. It must be understood, that the more continuous the fever the worse the prognosis and that prolonged fever is of graver import than a temporary rise. Recovery has taken place, however, even in cases with disseminated abscesses.

Chronic Type of Urinary Fever.—The chronic type of urinary fever is a frequent form, and is of great clinical importance. It may develop primarily as such or follow the acute form. The temperature is limited in range and intermittent in type, the elevations being moderate, in contrast to the sharp rises in the acute cases. Fever is not always present and in doubtful cases the temperature should be taken at frequent intervals.

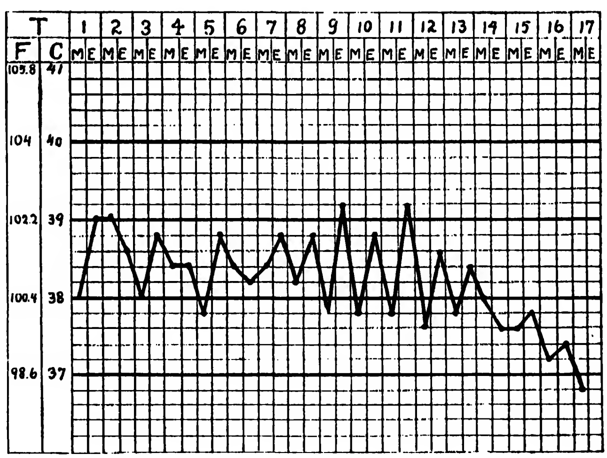


Fig. 229.—Chronic Urinary Fever, Occurring in a Case of Incomplete Retention from Prostatic Hypertrophy. (After Guyon.) These attacks usually follow catheterization, but may occur independent of it.

One of the constant and clinically important symptoms of this form are digestive disturbances with loss of appetite. The patients lose weight and become cachectic, even though there is no fever. When an acute attack of fever occurs, as it does sometimes in these cases, the patient becomes prostrated and keeps his bed for a day or two.

The urinary cachexia persists for some time and even after it is conquered the patients remain dyspeptic with sallow complexions for a while. If the

cachexia continues, the patients die of exhaustion, usually with uremic symptoms or with some complication or intercurrent disease. The chronic form of urinary infection is especially frequent in prostatics, who are, however, much improved by regular catheterization.

The prognosis of these very chronic types is very poor and especially when the cases are connected with chronic suppurative conditions of some part of the tract involving gradually the kidneys.

In general, the prognosis may be said to vary, no matter what the type may be, according to the virulence of the germs, the duration of the infection and the nature of the urinary lesions present. If the obstruction to the urinary flow can be removed surgically and the patient's urinary tract can be made to drain well, the prognosis becomes brighter. In the chronic forms, the infection has usually become so generalized and has affected the system so deeply that the prognosis is naturally least favorable.

Treatment of Urinary Fever.—The first consideration is prevention. This consists in so handling our cases during examination and treatment, that no infection can occur. For the most trivial surgical procedure, the strictest asepsis must be maintained, according to the principles laid down in the appropriate chapter. Certain preventive measures may be adopted also before, during and after surgical maneuvers on the urinary tract. In preparing for such procedures, one of the essentials is rest. Patients who arrive in an exhausted condition from travel, overwork or loss of sleep, should have one or more good night's rest, under the influence of a mild hypnotic if necessary. The bowels should be thoroughly moved and a large amount of water should be drunk in connection with a urinary antiseptic, as urotropin.

Just before the examination, especially if the patient has pus in the urine, a suppository containing morphin (gr. $\frac{1}{4}$) and quinin (gr. 10) should be given, together with an additional dose of urotropin (gr. 15). The examination itself should be carried on under the local influence of a weak solution of cocain and should the patient begin to tremble, perspire, clutch the table, contract the limbs, show a spasmodic contraction of the sphincter muscles, complain of pain or start to bleed, it is well to postpone the remainder of the examination until another time. A small catheter should then be inserted and the bladder filled with 1 : 3,000 silver solution, which the patient should be allowed to pass out afterwards. It is advisable not to resort to cystoscopy until the patient can well tolerate an ordinary instrumental examination. If tolerance is not established with the aid of cocain, general anesthesia may be needed for an examination of the urethra and bladder.

I have found that most of the cases of urethral fever that have followed examinations in the office, the clinic or the hospital, occurred in patients who have had too much instrumentation at the first visit, in other words, where too much haste has been used in examining. In the office, it has usually been in the

cases that have come from out of town, accompanied by their physician, when both wanted to return on the same day. In the clinic, it was usually in the interesting cases in which it was necessary to complete the examination in one visit, as otherwise the patient might not return.

Haste in examination is a very bad practice. Business men should be discouraged from having their cases rushed through as quickly as possible to save time. The only cases in which haste is needed are those of retention of urine and uremia. In retention, the preliminary treatment should be at once applied, including urotropin, a suppository of morphin and quinin and a hot sitz bath. The treatment for retention of urine, which has been outlined elsewhere, is then to be systematically followed until relief is effected. As soon as thorough drainage is established, the symptoms of urinary infection will usually begin to improve, and the patient has a good chance of recovery if the urinary flow is maintained together with the other necessary therapeutic measures.

In operating on the urinary tract, certain precautions should be taken to prevent urinary infection. Free drainage should always be established. In external urethrotomy operations, the parts should be frequently flushed with boric-acid solution and afterwards hydrogen peroxid should be injected through the urethra and allowed to escape through the perineal opening. The bladder may also be washed out with a 1: 10,000 solution of bichlorid. Wherever possible, drainage tubes or catheters should be employed in such a manner as to protect cut surfaces from contact with urine. In the after treatment of operations, the urethra and bladder should be washed at least twice daily and the attendants should see that the drainage tubes act properly and constantly. Special precautions should always be taken against infection in passing instruments through strictures, and, after the instrument has been introduced, the bladder should be filled with silver solution or some other antiseptic fluid, which the patient should be instructed to pass out, thus washing the urethra.

Treatment of the Attack.—During the acute attack, the patient is wrapped in blankets when the chill comes on and given hot and alcoholic drinks to provoke perspiration. A small dose of quinin should be at once given and repeated as indicated. The bowels should be moved and the urinary condition should be carefully looked after. Retention of urine, urethritis, cystitis, pyelitis and nephritis, should be treated according to the rules laid down in the appropriate chapters.

In the chronic cases, the treatment should be chiefly directed toward the gastro-intestinal tract. The patient should be partly on a milk diet and should receive frequent doses of laxatives. The digestive function should be stimulated by small doses of whisky and bitter tonics. Bathing, followed by frictions to stimulate the secretory functions of the skin, are also useful in some cases. Three grains of quinin three times a day usually benefit the patient consider-

ably. Whisky is in my hands another valuable remedy and the patients are given from two to six ounces a day, depending on the seat of the infection. When the lesion is below the kidney, the doses are larger. Citrate of caffein, in doses of from one to three grains three times a day, is also very beneficial when the patient is in a weak septic condition.

CHAPTER XIII

THE HISTORY OF THE CASE

A THOROUGH consideration of the history of a urinary case is essential in making an accurate diagnosis. It is well, as a rule, to allow the patient to tell his or her story first, interrupting only to bring out more clearly points of interest that might have an important bearing upon the condition. It is advisable then to take the history in a systematic way, both in order to make it easier of interpretation and to have the records that will be of value for future study. I will, therefore, present herewith a copy of the cards (Figs. 230 and 231) that I am in the habit of using for men and women respectively, showing the methods that I have employed for a number of years in a large hospital clinic and in my private practice.

It is my intention to present, first, a brief consideration of each of the headings in my history chart and the important points they bring to the surgeon for consideration, and to outline the steps of the routine examination of a case in the office. In other chapters I discuss more in detail individual symptoms and groups of symptoms observed in urology.

Age.—The age of the patient is very important as pointing to the various diseases that may occur at certain periods of life. In children, we have but few urinary troubles. If there are any, they are due to congenital stricture, especially near the meatus, to the irritation of a tight prepuce, to some nervous affection or to vesical stone; all of which give rise to frequency of urination and the last named to some pain and tenesmus.

As the individual grows older, the diseases of youth are to be considered, principally due to gonococcus infection and tuberculosis of the urinary tract. The varieties of the complications of these two infections are numerous, involving the urethra, bladder, ureter and kidney, as well as the genitals in both sexes.

In early manhood and womanhood tuberculosis is still common; calculus is more common than in the earlier periods; the gonococcus infections are slightly less common, while their results—stricture, cystitis and diseases of the internal genitals (the prostate and vesicles in men and the uterus and tubes in women)—are more often brought to our attention. Uterine and renal displacements are more common in women, as well as urinary troubles dependent on childbirth.

In middle life, tuberculosis is less frequently met with, as are also the acute gonococcus infections. Stricture of the urethra is more common, while kidney and bladder troubles occur with about the same frequency as in early manhood, as

Name Diagnosis

Address Age Referred by

Date Occupation Nativity M. S. W.

Family History

Past History

Present History

Principal Symptoms

Pain

Discharge

Character of Urination

Character of Urine, (pus, blood)

EXAMINATION

Standing { Genitals
Discharge (smear)
Urine 1st 2d
Prostate
Vesicles
Urine 3d

Lying { Urethra
Bladder
Urine 4th, (residual)
Kidneys

LABORATORY REPORT ON URINE AND DISCHARGES

Clear or Cloudy, Color Odor Reaction Sp. Gr.

Albumin Sugar Urea Indican Total Solids

Crystals Mucus Connective tissue

Red Blood White Microorganisms

Epithelia

Casts Other features

Discharge (smear)

Remarks on Urine and Discharges

Fig. 230.—Male History Card.

do also the bladder affections depending on diseases of the spinal cord and brain.

In old age, prostatic changes occur, associated with vesical and renal symptoms of a surgical nature. Malignant tumors and calculi are more frequently found. Changes in the kidney, due to circulatory disturbance, take place with increased frequency; while tuberculosis and the diseases dependent on gonococcus infection are not so common as in earlier life.

Occupation.—To know the patient's occupation is useful in determining the possible effects of traumatism or of continuous muscular effort, the frequency of exposure to cold, wet and other influences of the weather, and the general mode of life, sedentary or otherwise.

Civil State.—In men, the civil state, whether single or married or widower, has a certain bearing upon some urinary diseases, especially those connected with sexual disturbances. Thus gonococcus infections are more common in

Name			Diagnosis	
Address		Age	Referred by	
Date	Occupation	Nativity		M. S. W.
If Married when?	No. of Children –		Abortions	
Family History				
Past History				
Present History				
Principal Symptoms				
Pain				
Discharge				
Character of Urination				
Character of Urine, (pus, blood)				
Menstruation (character of)				
		EXAMINATION		
External	Kidneys			
	Genitals			
	Discharge			
	Urine 1st	2d		
Internal	Uterus			
	Tubes			
	Ovaries			
	Urethra			
	Bladder			
	Urine (residual)			
		LABORATORY REPORT ON URINE AND DISCHARGES		
Clear or Cloudy, Color	Odor	Reaction	Sp. Gr.	
Albumin	Sugar	Urea	Indican	Total Solids
Crystals	Mucus		Connective tissue	
Red Blood	White		Microorganisms	
Epithelia				
Casts		Other features		
Discharge (smear)				
Remarks on Urine and Discharges				

FIG. 231.—FEMALE HISTORY CARD.

single people; congestion of the prostate, prostatitis and vesiculitis, from an irregular sexual life, are more common in widowers, men in the army and navy, travelers for business houses or men in other callings where for various reasons the sexual life is not well regulated.

In women, the question of marriage, childbirth and abortion has an obvious bearing upon the diseases of the genital, and, indirectly, of the urinary tract, as causing displacements and the prolapse of the bladder (cystocele), as well as disturbed bladder functions due to diseased adnexa.

Race.—The patient's nativity or race has much to do with the prevalence of certain urinary diseases. Thus, in Spanish-Americans, stricture, prostatitis, stone and nephritis are most common; impotence in men and nephroptosis in women.

In the Italians, we find a prevalence of stone and tuberculous lesions. In the Jewish race, diabetes and bladder, prostatic and seminal vesicle disturbances are to be looked for.

Family History.—The family history of the patient is the next heading to be filled out on our card. Certain urinary diseases seem to be influenced by heredity. The uric-acid diathesis, with its tendency to deposit crystalline masses and to form stones, is unquestionably found very frequently in successive generations. Bright's disease, arteriosclerosis, diabetes, diseases of the spinal cord and brain, hysteria and neurasthenia with their special disturbances in the urinary function, are all unquestionably influenced by heredity. The existence of tuberculosis in the family will always lead to a suspicion of tuberculous urinary lesions if the symptoms of a chronic process in the urinary tract are present, even though the lungs of the patient show no trace of tuberculous lesions.

It is said that there is no hereditary predisposition to prostatic hypertrophy; but I have noticed the occurrence of the disease in members of the same family and prostatics have occasionally told me that their fathers had had the same trouble. The same is said to be true of strictures, to which, according to Thompson, there seems to be a family predisposition.

Cancer of the kidney, the prostate and bladder is another disease in which the heredity is to be carefully investigated. The predisposition to malignant tumors, when present, goes far toward making us watchful for the presence of such growths in the urinary tract.

Past History.—When inquiring for data to be written under this heading, we begin at childhood, asking as to the occurrence of infectious diseases. The occurrence of scarlatina, diphtheria, etc., will make us think of possible nephritis. The various diseases gone through at an early age to the present day should be noted. Rheumatic attacks are associated with the uric-acid diathesis or stone; protracted coughs point to tuberculosis; attacks of renal colic indicate a stone. These are among the phenomena to be considered in the past history. The occurrence and number of attacks of urethritis make us look for stricture, prostatitis, cystitis and renal affection; while syphilis points to bladder affections through atony of its walls due to a spinal sclerosis. Traumatism and urological or other operations are also to be noted, if they have occurred, as they have important bearings on the etiology of the present affection.

Present History.—Having thus elicited by a few leading questions the heredity and past history of our patient, we come to the consideration of the present illness, i. e., of the complaint for which the patient needs our assistance. Here it is usually best, in order to obtain a consecutive story, to ask when the patient last felt perfectly well. Beginning with this data, with a little urging, the leading events of the illness will be related to us, which we write down in a condensed form on the lines following the heading "present history."

The patients, in relating their present history, will usually speak of pain,

disturbed micturition, a discharge, the presence of blood in the urine, or the passage of urine which they describe as "not being clean." They may also complain of inability to attend to their work, not only on account of urinary disturbances, but also on account of a feeling of weakness or sickness. Patients who complain of weakness and sickness, which may be constant or intermittent, may be suffering from some constitutional trouble, as a nephritis, a carcinoma or tuberculosis. When such a condition occurs in the form of attacks, it may be due to a congestion in some part of the urinary tract, to febrile attacks due to impediment to the escape of pus, and to other causes which they cannot account for. Loss of weight is generally due to the condition or diseases just mentioned. As the leading symptoms, however, are those which I at first outlined, I will take them up more in detail; and these are so important that I have placed them on the card (see Figs. 230 and 231), in order that I may not omit any of them in taking the history of the case.

Principal Symptoms.—The first thing to be asked after the patients have given us their version of the present illness is, What is the principal symptom—i. e., the one complaint that has led to the visit? The answer to this question will often tell us what the disease is; as, for instance, discharge will lead us to believe that the patient, if a man, has a urethritis, especially if it is associated with a burning on urination, alone or associated with frequency; or, if a woman, that it comes from her urethra or vagina. A hemorrhage from the urinary tract will lead us to think of tumor. The passage of dirty urine will lead us to think of pyuria. A sudden, sharp pain darting down the ureter will indicate renal calculi passing down the tract, etc.

Pain.—In the great majority of cases, pain is one of the symptoms, if not the leading symptom, complained of. The subject of pain in urinary diseases is discussed more at length under the heading of Symptomatology. In taking the history, the duration, character, intensity, localization, chief seat and directions of pain should be noted. The relation of pain to rest and motion, exercise or jarring, micturition, defecation and to the sexual organism, are also points of interest.

The *character of pain* complained of by patients with urinary diseases, varies considerably from the acute, colicky, sudden, sharp pain of stone traveling down the ureter, to the feelings of discomfort, dullness, heaviness, or of an indescribable irritation of an indefinite kind in some locality.

Pain in the loin may mean involvement of the kidney and may be either surgical or medical. The diseases one must look for when pain in the loin is present are renal stone, tuberculosis, tumors, movable kidney, nephralgia, perinephritic abscess, pyelitis and pyelo-nephritis. The pain in the loin is usually in the back, on one side, beneath the free border of the ribs, although it may also be found in the corresponding situation in front, or beneath the angle of the ribs, in the ileo-costal space.

The character of the pain may be sharp, as in the passage of calculi, or of tubercular accumulations, in movable kidney, or in nephralgia from nephritis. In these same conditions, a dull pain may be present, or a heaviness, as in tumor of the kidney. These pains may radiate down the ureter in the direction of the groin or bladder, especially in cases of stone.

Pain in the ureter is reflected up toward the kidney, or downward toward the bladder or testes. It may also have a point of maximum severity, as in a displaced kidney, the pedicle of which has become twisted at a certain point (Dietl's crisis), or in the presence of calculus; the larger, rougher and more jagged the stone, the more acute is the pain.

Suprapubic pain is usually dull and accompanied by a sense of pressure and fullness. It is most marked in cases of sudden retention of urine, when there is, in addition, a cramplike feeling. It may also be present in inflammation of the bladder from any cause, as from extensions from the urethra, stone, tuberculosis or tumor of the bladder, being more marked and more acute in cystitis due to stone and tuberculosis. A sense of discomfort or fullness in the suprapubic region is frequently due to an involvement of the seminal vesicles.

Pain in the groin, in the male, points to trouble with the testes, the cord or with the seminal vesicles. In women, it means involvement of the adnexa. If the pain is of a dull character, it is due to inflammation of the seminal vesicles. When there is pressure on the ejaculatory duct on one or both sides, from prostatic inflammations, pain in the groin may also be present. Pain in the groin is elicited when the vas deferens is inflamed, or the ampulla alone is involved. In epididymitis, due to the extension from the urethra along the vas deferens, pain in the groin precedes the pain in the epididymis.

Pain in the perineum in the male is usually due to stricture, deep-seated urethritis, posterior urethritis, acute or chronic prostatitis, or prostatic hypertrophy or Cowperitis. In women it usually points to laceration of the perineum or hemorrhoids.

DISCHARGE.—This symptom will be studied more in detail in the chapter on the subject. In taking the "present history," however, one of the symptoms complained of is often a discharge. In men, we inquire as to the amount, the character and time of occurrence of the discharge. If profuse and purulent, it points to an acute urethritis; if very scanty and mucoid, it indicates a chronic process. When the discharge is associated with defecation and is glairy or glycerinlike, it is due to prostatorrhea or spermatorrhea. In women, a thick discharge coming from the vagina, called by some vaginitis, is generally associated with leucorrhea and endometritis, and when accompanied by burning on urination, points to a urethritis. In both cases, if acute, the gonococcus should be looked for.

Character of Urination.—Under this heading, the two chief points to be considered are the frequency of voiding urine and any difficulty or irregularity in voiding it.

Frequency of urination is one of the most important symptoms to be considered in urinary surgery, and, next to pain and discharge, is the one principally complained of. Frequency, more marked during the day, in men, points to stricture, posterior urethritis, prostatitis, vesiculitis, cystitis and vesical calculus; in women, it indicates cystitis, vesical calculus, urethral stricture, urethral caruncle, uterine displacement and growths, and adhesions due to diseases of the adnexa. Frequency, occurring principally at night, indicates prostatic hypertrophy and prostatitis, in men; in women, pressure on the bladder in certain cases of uterine disease, as fibroma or carcinoma. Tuberculosis of the bladder causes frequency of urination both day and night in both sexes. Tenesmus at the time of urination, points, in men, to an acute inflammation of the posterior urethra, of the vesical neck; to an acute prostatitis; to a prostatic hypertrophy with congestion or cystitis; to a stricture; to vesical calculus; or tuberculosis. In women, it points to cystitis, calculus and tuberculosis of the bladder, or urethral caruncle.

Difficulty in passing urine, in men, points to obstruction as prostatic hypertrophy or stricture; to vesical calculus, or to atony of the bladder from sclerosis of the cord or lesions giving rise to paralysis. In women, the same causes may give rise to difficulty, except prostatic hypertrophy, and with the addition of cystocele, uterine displacements and prolapse and adhesions to the bladder, holding it out of its normal position. Retention and incontinence of urine will be discussed in detail in the chapter on these subjects.

Character of the Urine.—The patient's impression as to the character of the urine is set down under this heading. It enables us to elicit the probable presence of blood (hematuria), of pus (pyuria), of a milky substance (chyluria), of a brick-red sediment (uraturia), of ammoniacal fermentation (cystitis), or of sulphurous odor (cystinuria, pyelo-nephritis). Furthermore, a general idea of the quantity voided (oliguria, anuria, polyuria), may also be obtained from the patient's statement.

Character of the Menstruation.—On the female card will be seen the question, "Character of Menstruation?" This is not of such great importance, but is of some significance, for, although the genital tract in the female is not in such close contact with the urinary as in the male, nevertheless they are sufficiently associated for us to consider the function of the main genital organ. An increased flow, or frequency of flow, from the uterus might mean a fibroid tumor, an endometritis, or a malignant growth. A cessation of flow might indicate pregnancy, tuberculosis or change of life. Uterine pain would indicate endometritis and displacement, all of which might have an important bearing on the bladder of the female.

CHAPTER XIV

GENERAL SYMPTOMS

BEFORE proceeding to the urological examination, which is outlined on the chart (Figs. 230 and 231), the general symptoms should be considered and a general examination made, more or less minute according to the nature of the case. A surgeon, even if he devotes himself largely or exclusively to urological conditions, should not neglect to study his patient's general condition in every case, and thus avoid that evil of specialization, the overlooking of important general features, in the concentration of his thoughts upon the local condition. The patient's appearance, nutrition, gait or posture, the condition of the tongue, the character of the pulse, the rate of respiration, the size of the pupils, are all signs which offer important diagnostic data and which should never be neglected.

(1) **Nutrition.**—The size and weight of the individual is important from several view points. For instance, tall, spare persons, especially women, are more liable to have movable kidneys, whereas, this affection is usually absent in shorter and heavier persons. The reasons for this are fully discussed in Chapter XXII. Progressively decreasing weight, in other words, emaciation, may point to diabetes; or when accompanied by local urinary disturbances, to chronic suppurative or tuberculous diseases in that part of the genito-urinary tract. A loss of weight is also incident to certain types of chronic nephritis, whereas, an extreme form of cachexia would make us suspect malignant disease.

Obesity sometimes accompanies the earlier stages of diabetes. Increase of weight with edema would at once naturally call attention to renal diseases. It may be noted that increase of weight and good muscular development is not incompatible with the presence of nephritis, even in an advanced degree; and that tuberculosis of the kidney in its initial stages, and also when the kidney is half destroyed, is seen at times in individuals in apparently perfect health.

(2) **The Skin.**—So far as the color of the skin is concerned, a waxy pallor is quite characteristic of amyloid kidney, while lesser degrees of pallor occur in chronic nephritis. Pallor with a hectic flush, points to tuberculosis, while with puffiness of the eyelids, it points to renal diseases. The pallor of the face of gin drinkers, so frequently seen in England, is typical of the nephritis occurring in these types of alcoholics. Hepatic disorders, especially those common to indi-

viduals coming from the tropics, are characterized by a yellowish, sallow hue. In some diabetic patients the skin is also yellow and peculiarly dry. A sallow, yellowish tint is also seen in chronic malaria, while a bronzed hue is characteristic of diseases of the suprarenal capsule.

Along with the color of the skin, we note the condition of the mucous membrane. The latter is pale in anemic conditions, while the presence of cyanosis, represented by blue lips and livid finger nails, would point to badly compensated heart disease so frequently associated with renal affections.

There are a few eruptions of the skin which can be connected with urinary disease. In diabetes, we frequently find furuncles and carbuncles, while in the advanced stages gangrene may occur. Pruritus occurs in nephritis and diabetes. Ecthymatous eruptions, which are sometimes seen on the legs or on other parts of the body, occur in patients with constitutional disease which lowers the vitality of the skin, such as nephritis, syphilis, tuberculosis, alcoholism, etc.

(3) **Posture.**—The posture and the gait of the patient may sometimes be of value in diagnosis. In ascites, or abdominal tumors, we have a peculiar gait, with the body bent backward and the feet spreading widely to aid in the support of the added weight. In locomotor ataxia, the well-known, peculiar gait and the inability to balance oneself with the eyes closed, is of interest in connection with cases of retention of urine and difficult micturition, accompanying lesions of the cord. Patients with partial hemiplegia walk with a dragging of one extremity and their urinary symptoms are at once referred to the central nervous system. Patients walking with a stooping posture, or limping so as to favor one side, may be suffering from renal colic, from perinephritic abscess, from inguinal adenitis or from epididymitis.

The position of the patient in bed in renal colic and in perinephritic abscess, is such as to avoid the contact of anything with the painful parts. Usually the body is bent laterally toward the diseased side. In active renal colic, the thighs are flexed and even the upper part of the trunk is bent toward the source of the pain. In acute prostatitis and in abscesses about the rectum, the thighs are drawn up and the patient sits on one buttock, although he prefers usually a reclining position. In vesical pain and difficulty in passing water, the patient may squat while in the act of micturition, or stand clutching for some support and straining to pass water. These are but a few examples of the various postures assumed characteristically by patients with urinary disease.

(4) **Odor.**—An abnormal odor discernible on approaching the patient sometimes gives us a clew regarding the trouble. Thus an ammoniacal odor points to incontinence of urine, usually from some obstruction, such as stricture or prostatic enlargement or from atony of the bladder due to diseases of the spinal cord. A necrotic odor points to the presence of sloughing or gangrenous conditions affecting the lower part of the tract, or to sloughing venereal ulcers or warts.

(5) **General Behavior.**—The general behavior of the patient is often of value in leading us into the right channel for diagnosis. Neurasthenic patients exhibit a peculiar uneasiness, with purposeless movements, such as shifting the legs, etc.; they easily flush and pale under questioning, their speech is at times thick and hesitant. In hysteria, a vague absent-minded expression of the face, a lack of consecutive expression of thought, a rambling speech, often very voluble, and either extreme anxiety or an unaccountable levity are noted by the physician. In sexual neurasthenia, there is usually a touch of melancholia and a hypochondriacal tendency to exaggerate all symptoms and to draw a very dark picture of the complaint. Thus, from the very appearance of the patient, we are often led to think of the possibility of disturbances in the genital organs connected with urinary disease.

In bed-ridden patients, the condition of the mind in such states as uremia, urinary fever and sepsis needs attention. The details will be found in the appropriate chapters. Here we may mention merely the confusion of ideas, the drowsy apathy and the gradual clouding of sensation in uremia.

(6) **The Tongue.**—The patient's tongue has a bearing upon the general condition, though it may not necessarily show anything connected with his urinary organs. We may mention, however, the dry, coated tongue of the typhoid state accompanying septic conditions (urinary fever, septicemia, pyemia), and that a dry tongue should always indicate a serious condition in urinary diseases, before as well as after operations on the urinary organs.

(7) **Pulse and Temperature.**—The pulse and temperature are to be taken in every case in which constitutional trouble is suspected. A rapid pulse with high tension would lead us to think of renal trouble, although a patient may have normal blood pressure when uremic; a pulse increased in rapidity but not in tension, is found in urinary fever or sepsis. A feeble pulse, a dicrotic and easily compressible pulse, or, on the other hand, a bounding pulse, may be seen in valvular affections of the heart complicating nephritis.

Whenever fever is found to be present, we should first of all seek the source of the rise of temperature by making a careful routine examination of the urinary tract. The blood should be examined for malaria and typhoid fever when fever occurs for any length of time. Many patients are treated for malaria for a long time when in reality they are suffering from suppurative renal diseases or from complicated renal calculus. Fever occurring in a patient leading a catheter life or after other instrumentation, would at once arouse the suspicion of urinary fever or sepsis; the same may be said of fever occurring after an operation on the urinary tract. Acute febrile attacks in patients with urinary disease, who have previously been in apparently good health, usually point to the prostate gland, some complication of the urethra or the kidney. In the ordinary form of nephritis, there is no elevation of temperature; but there is a distinct febrile movement in the suppurative nephrites, including pyelo-

nephritis, pyonephrosis, abscess of the kidney and stone or tuberculosis in the kidney complicated by secondary infection, etc. In abscess of the kidney, the temperature may range from 99° to 105° F., falling abruptly when the abscess ruptures. In pyelo-nephritis, the range is lower and the type more chronic. In pyonephrosis, the type is often of a remittent typhoid character or so markedly intermittent as to simulate malaria. When the pus is discharged from the kidney after having been retained for a time, there is a remittance or an intermittence of fever. In suppurative conditions of the kidney in which there is a sudden obstruction to the outflow of pus, as in stone, the fever may set in sharply with a chill, followed later by sweating.

In perinephritic abscess, the patient runs a septic temperature with all its characteristics, including great emaciation. Movable kidney may also be accompanied by chills and fever, occurring from time to time if pyelitis is present. In acute nephritis, there may be an onset of chills and fever and a rise of temperature throughout the disease.

There is no characteristic temperature in uremia. When this condition is associated with acute or chronic inflammatory or suppurative states in the kidney, the fever of the nephritis dominates the scene. A subnormal temperature may be observed during the uremic attack itself.

In prostatic inflammations, a rise of temperature may be noted, especially in the acute form of prostatitis, which is usually ushered in by a chill. During the abscess formation, profuse sweating may take place, especially at night. Cases of chronic abscess of the prostate may be unaccompanied by fever, or only give rise to a very slight febrile movement. In periurethral inflammations, sepsis of a varying degree, with or without chills, shows itself, depending on the extent and character of the inflammation. Sweating generally accompanies these cases. The presence of both pus and urine in the cellular tissue, as in cases of urinary extravasation, gives rise to the most severe and fatal sepsis.

(8) **Respiration.**—The rapidity and character of the respiration may be altered in the course of certain urinary diseases. Marked dyspnea may accompany chronic interstitial nephritis, especially in uremic patients. Rapid and shallow respiration may be noted in perinephritic abscess, after injuries of the kidney (rupture of the organ), or as a result of the pressure of a large kidney upon the diaphragm. The Cheyne-Stokes breathing, noted in interstitial nephritis with heart disease and in advanced cases of uremia, must also be mentioned. Complicating pleurisies or broncho-pneumonias, such as occur in septic patients, will, of course, increase the rapidity and alter the character of the breathing.

CHAPTER XV

EXAMINATION OF PATIENTS

It is my desire in this chapter to outline the steps in the examination of male and female patients in as uniform a manner as possible. The result of my study of the different methods of examination, in hospital, clinic and private practice, has led me to outline the following system as being at present the most convenient for the uniform urological examination of male and female patients. Doubtless in the near future, as this specialty develops, better methods will be established.

UROLOGICAL EXAMINATION OF PATIENTS

Position of Patients during Examination

Male

(1) Patient at full length on table	Abdomen. Kidneys. Bladder. External genitals. Discharge (smear).
(2) Patient standing	1st urine. 2d urine. Prostate. Vesicles. 3d urine.
(3) Patient at full length on table	Urethra. Bladder. 4th urine (residual).

Female

(1) Patient at full length on table	Abdomen. Kidneys. Bladder.
In gynecological position	External genitals. Discharge (smear).
(2) Patient on commode	1st urine. 2d urine.
(3) Patient in gynecological position on table	Uterus. Tubes. Ovaries. Urethra. Bladder. 3d urine (residual).

Examination of the Abdomen.—When the abdomen is examined, the patient should lie on the table full length, with the legs extended (Fig. 232). The examination of the abdomen is practically the same in both sexes. The upper zone, including the liver, stomach, spleen and kidneys, is first palpated, and

LABORATORY REPORT ON URINE AND DISCHARGES

Clear or cloudy.	Color.	Odor.	Reaction.	Specific gravity.
Albumin.	Sugar.	Urea.	Indican.	Total solids.
Crystals.	Mucus.		Connective tissues.	
Red blood.	White.		Microörganisms.	
Epithelia.				
Casts.			Other features.	
Discharge (smear).				

Remarks on urine and discharges:—
Treat.

then the lower zone, including the suprapubic and inguinal regions. An enlarged liver with a tongue-shaped right lobe, is very frequently mistaken for a

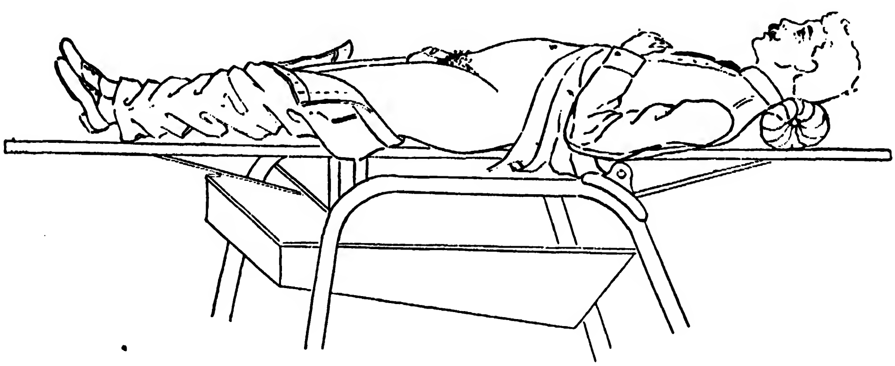


FIG. 232.—PATIENT LYING AT FULL LENGTH. First step in the examination of the male.

kidney, as is an abscess or a hydatid cyst of that organ, as well as enlarged gall-bladder. There is also a variety of enlarged spleen, with a well-rounded lower border, that we should guard against, as it resembles clearly a kidney, as do also abdominal granuloma, enlarged postperitoneal glands and tumors formed in tubercular peritonitis.

In urology, however, the palpation of the kidneys is the most important. If they are normal, they cannot be felt and the examination is not accompanied by any pain or tenderness. If some surgical trouble is present, they can generally be outlined and may be tender on pressure. Tenderness is often not present even in kidneys that are badly diseased.

A counterbalance table, which is used for all our examinations, gives the patient every position, from a lying to a sitting posture. It is well to examine the kidneys first while the patient is lying flat, with the legs extended (Fig. 233), and then with the knees flexed; after this, the back of the table is gradually raised until the patient is in a sitting posture (Fig. 234). During these move-

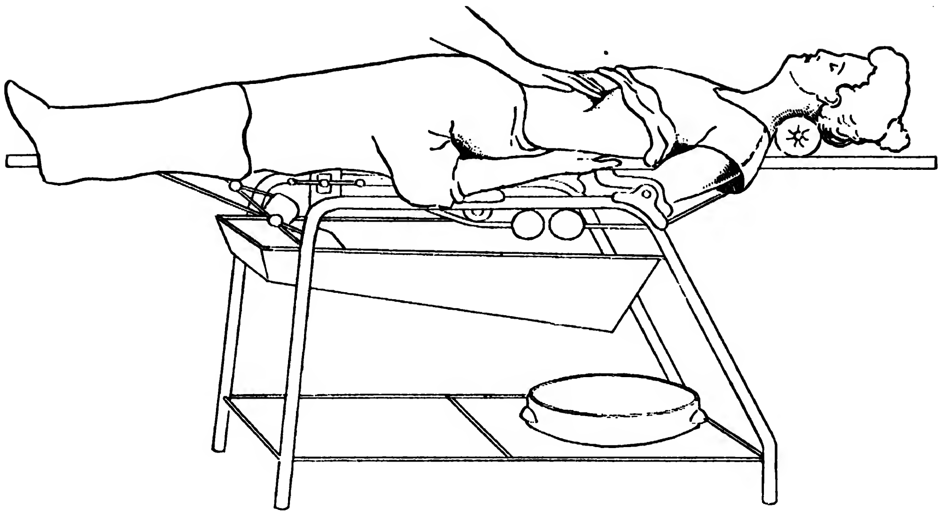


FIG. 233.—EXAMINATION OF THE KIDNEYS, THE PATIENT LYING FLAT.

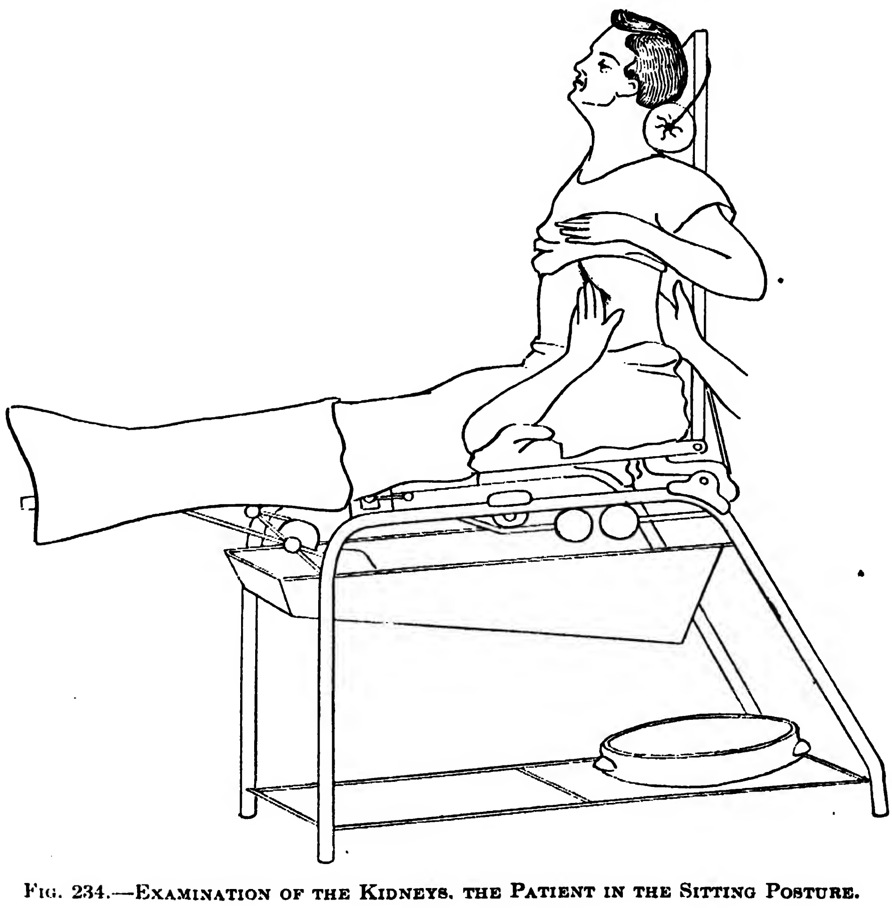


FIG. 234.—EXAMINATION OF THE KIDNEYS, THE PATIENT IN THE SITTING POSTURE.

ments, the examiner should stand on the side of the patient adjacent to the kidney he is examining. If on the right side, he should have his right hand in front on the outer side of the rectus muscle and the left hand on the back below the twelfth rib. The position of the examiner and his hands should be exactly reversed in examining the other side. If the examination in the dorsal position is not satisfactory, the patient is placed on the healthy side with the knees slightly flexed, thus allowing the organs to fall toward the healthy side (Fig. 235). The object of bimanual palpation is to feel the kidneys between the

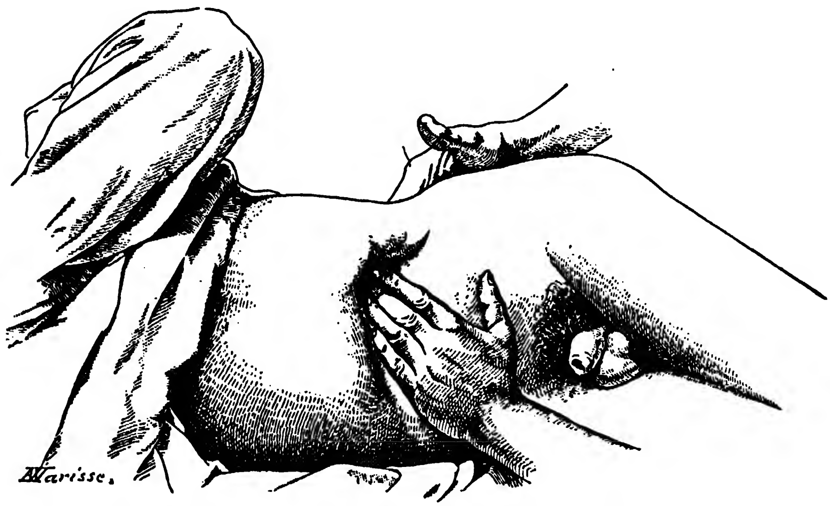


FIG. 235.—EXAMINING THE KIDNEY, WITH THE PATIENT LYING ON THE HEALTHY SIDE.

fingers of the two hands. Therefore, the patient should be instructed to breathe deeply, thus increasing the extent of the renal excursion. With every expiration, the fingers are pressed more deeply in until the kidney region is reached. The examiner must not press hard when examining for a movable kidney, as it will slip away without his being able to detect it. If the kidney is enlarged, it should be ballotted between the hands, as in this way its size, shape and consistence can be better determined. Sometimes it is advisable to have the patient stand during examination.

In my experience, the variety of kidneys that we are more often called on to treat are the movable, the tuberculous, the calculous and the so-called surgical, pyelo-nephritis following cystitis. In these cases, the organ is often tender and increased in size. In marked cases of hydronephrosis, pyonephrosis and cystic kidney, the mapping out of the organ is even easier.

In the lower zone of the abdomen, we may encounter tumors, appendicular or intestinal fecal accumulations, an enlarged bladder, with residual urine, and, in women, a gravid uterus, tumors of the uterus and adnexa, exudations and abscesses due to diseases of the tubes, periurethral and extraperitoneal suppuration.

Examination of the External Genitals.—MALE GENITALS.—I notice first the size and shape of the organs, whether they are well formed or misshapen (epispadias, hypospadias, etc.). The condition of the prepuce, the presence or absence of such lesions as nodules or ulcerations, verrucæ, abscesses, lymphangitis are noted.

The *meatus* is next inspected, it being noted whether it is large or small, normal or distorted. An induration at the meatus, with the lips pressed together, may indicate the presence of an initial lesion of syphilis, or if ulceration is present, a chancroid infection may be suspected. The presence of urethral *discharge* is also noted at this inspection and a smear should be taken for microscopic examination. This is done by sterilizing a platinum wire loop by heating it red hot over an alcohol lamp, cooling the loop and taking a drop of the discharge from the meatus upon the loop. The discharge is quickly smeared very thin upon a clean glass slide, bearing a label with the patient's name or number.

In each of the examining rooms, a compact equipment is provided for taking smears, etc. Slides are kept in a wide-mouthed bottle. A glass rod with a platinum loop and an alcohol lamp are also on hand on each table. The loops are used for obtaining urethral, cervical, vaginal or other discharges which are smeared on the slides in a thin layer. The platinum loop is heated to a red glow before and after taking each smear.

If the discharge is very scanty, it is sometimes possible to obtain a sufficient amount by milking the urethra from behind forward and expressing its contents into the fossa navicularis, where it can be taken up with a loop.

Caution must be observed in drawing hasty conclusions as to urethral inflammations in the presence of a discharge, as many cases of persistent urethral discharge are due to the presence of an initial lesion or other infection which we do not yet understand.

The *urethra* is further examined by external palpation along its entire length, the presence of nodules, indurations, swellings, abscess formations or fistulæ being noted. The *testes* are next palpated, tenderness, enlargements, nodules, etc., of testes, epididymis or cord being noted, indicating the existence of inflammation, tuberculosis or syphilitic processes, the beginning of malignant tumors, etc., as well as the presence of hydrocele, varicocele or hernia.

FEMALE GENITALS.—In order to examine the external female genitals, the patient must be brought down to the edge of the table in the gynecological position (Fig. 236) and the same conditions must be looked for as in the male, viz.: deformities, swellings, nodules, ulcerations, verrucæ, abscesses and lymphangitis. The glands of Bartholini are pressed upon to see if there is a purulent discharge from the ducts. The presence of vaginal discharge is noted and a smear taken if it is present. The labia are then separated and the vestibule sponged with a bichlorid solution, 1 : 5,000. The forefinger of the left hand is then inserted into the vagina against the urethra at the point where it leaves

the bladder and is then drawn down toward the meatus, making pressure all along the canal. In case discharge is seen, it is taken on a slide if there is sufficient quantity, otherwise a platinum loop is inserted into the meatus and an effort made to secure a specimen (see chapter on Discharges).

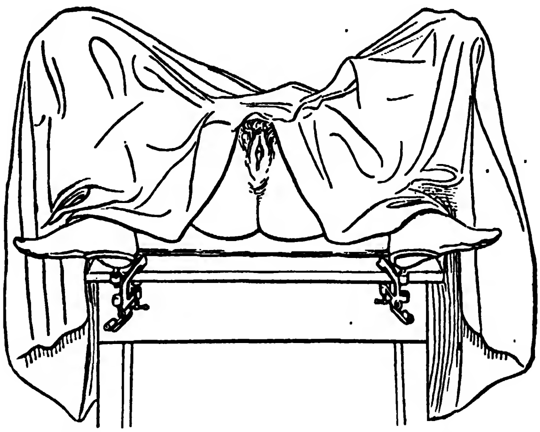


Fig. 236.—Position for Examining the Female Genitals and Urethra.

Note.—So far the examinations have been on the table in both sexes; but they must now be considered separately on account of the difference in the anatomy of the sexes. I will, therefore, first give the procedure in the case of the male and then take up that of the female.

Examination of the Male Patient Standing.—The First Urine.—The patient is next directed to stand up and is handed a glass cylinder by the examiner. Into this he is instructed to pass a portion of his urine (Fig. 237). Frequently in the embarrassment caused by the examination, or for some other psychical reason, the patient is unable to urinate promptly at this moment. In order to aid him as much as possible, two measures may be adopted. The first is to leave him to himself, the second is to allow a thin stream of water to trickle from a faucet in the room in which he is being examined. This acts on the motor centers of the bladder through the mental impression which suggests urination through the very sound of the stream of water.

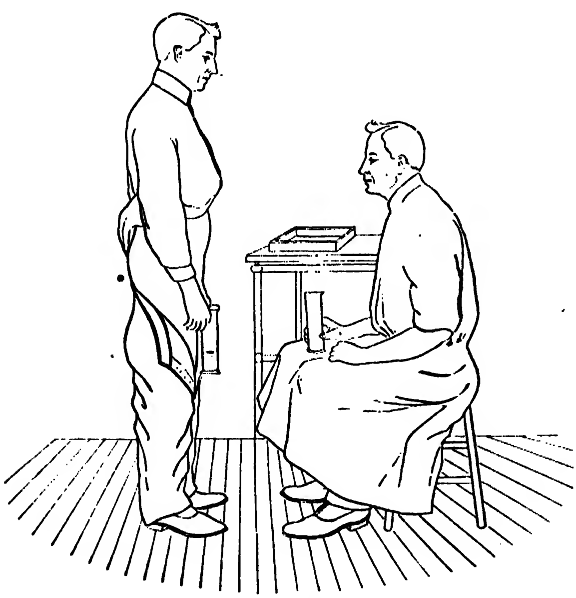


Fig. 237.—Male Patient Urinating in a Glass Cylinder

The size, shape and force of the stream is noted, if possible, when the patient passes water. A healthy man with a normal urethra and bladder passes a fairly large stream, projecting from his body at a distance of from three to five feet

when standing up. A man with a small meatus has a smaller, but usually a forcible stream. A sudden interruption of the stream which begins normally, often points to the presence of stone in the bladder. On the other hand, a stream which slowly becomes smaller and less forcible points to either some obstruction, such as stricture, prostatic enlargement, acute congestion of the prostate, acute or chronic prostatitis, or to a lack of tone of the bladder. Further details as to the character of the stream will be found in the chapter discussing the subject of urination.

After the first urine is passed, it is held up to the light to see if it is light or dark, clear or turbid, and examined for pus, shreds and mucus. The significance of these various elements is considered more in detail under the subjects of urine and discharges.

Second Urine.—The patient is then handed a second glass cylinder, of the same size and shape as the first, and is asked to void a second portion of his urine, but is warned not to pass the entire contents of his bladder. The second urine is inspected in the same way as the first, any cloudiness, shreds or a deposit of pus, etc., being noted.

Prostate and Vesicles.—The patient is then told to bend forward. He leans over, resting on his hands placed on a table. The body is at an angle of

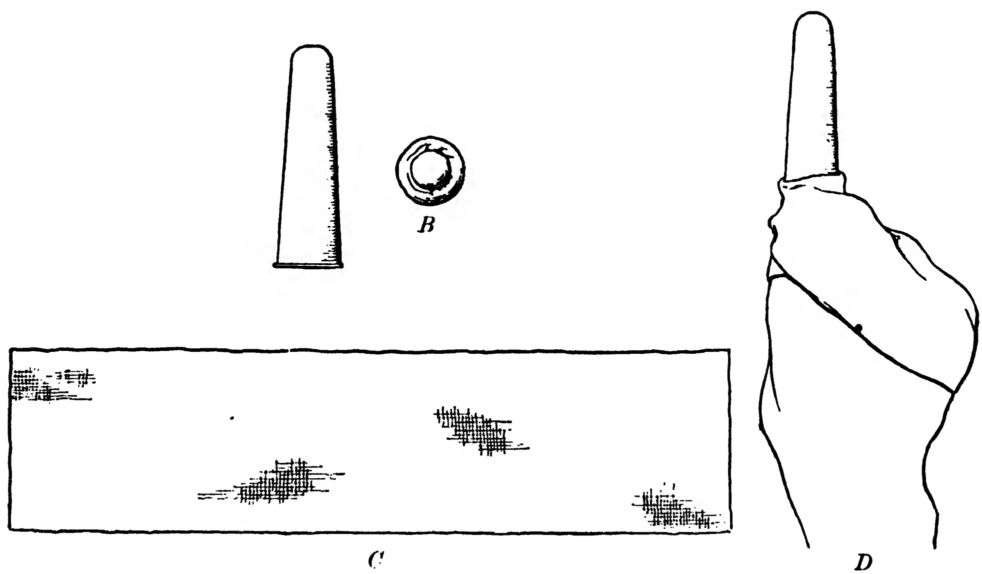


Fig. 238.—The Finger Cot.

A, finger cot unrolled.
B, finger cot rolled up.
C, piece of gauze to wind about the finger.
D, the hand with the finger cot on the forefinger and the piece of gauze wound about it.

135 degrees to the perpendicular. The examiner places a finger cot on his finger (see Fig. 238) and winds a piece of gauze about the base of it to keep his finger clean. He then sits behind him and inserts the forefinger of the right

hand into the rectum and examines the prostate. He then presses the fore and middle finger of the left hand into the groin of the patient, thus pushing the vesicle down against the examining finger (Fig. 239). It is strange that much experience is necessary to examine well the internal genitals, but such is the case. The examiner notes the outline of these organs, the presence of nodules,

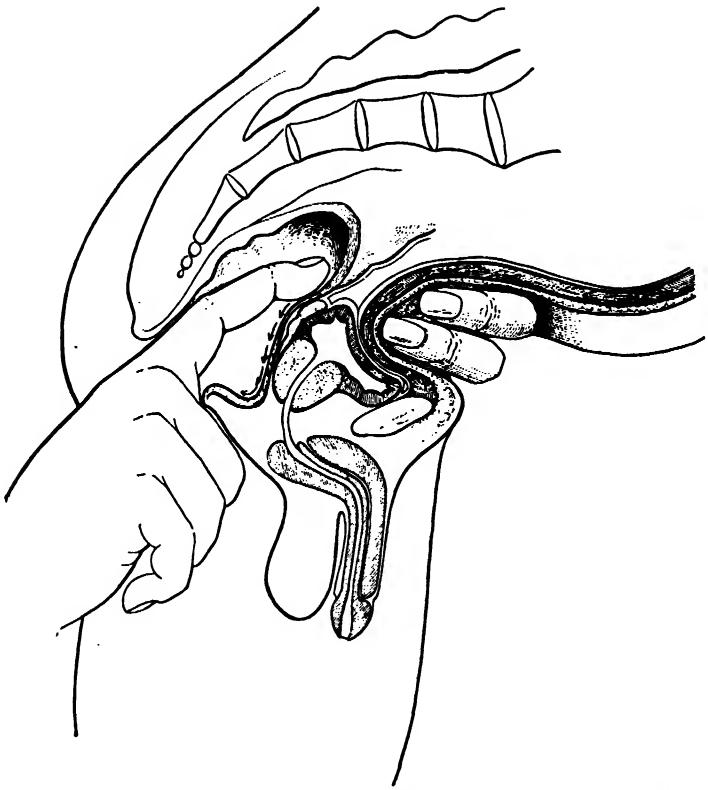


FIG. 239.—EXAMINATION BY RECTUM. The patient leans over the table and the examiner inserts his right forefinger into the rectum, presses the fingers of the left hand into the groin, and palpates the vesicles bimanually.

depressions, as well as the general consistence and tenderness of the parts. A hard prostate, either normal or small in size, may give rise to frequency of urination from a cause which cannot as yet be determined, though probably owing to pressure exerted by a very tense external capsule. A prostate which is soft and boggy indicates a chronic prostatitis, in which case the gland has become atonic. Nodules in the prostate show local areas of follicular inflammation or simple chronic or tuberculous prostatitis. An intensely tender, hot, swollen, enlarged turgid gland, with one or both lobes involved, is characteristic of acute prostatitis. An enlargement of the gland in young men without the acute signs just mentioned, but usually with nodular swellings, points to a tuberculous process. In elderly men, an enlargement usually indicates prostatic hypertrophy, or

else malignant growth. A shrunken prostate, with an irregular outline and with depressions or softened areas, shows the seat of former abscesses which have destroyed a part of the prostatic tissue.

Engorged, thick, tender vesicles point to an acute vesiculitis. Moderately distended vesicles with the walls not so thick, although tender, point to a subacute process, or to congestion, with some retention of vesicular secretion. When the vesicles are tender and cannot be outlined, they are probably simply congested.

In the chronic condition, vesicles have thickened, atonic walls perhaps full of vesicular secretion and inflammatory products, due to a subacute inflammation probably associated with a thickening of the neck of the vesicle or pressure on the ejaculatory duct by the prostate. The vesicles often have a pasty feeling and dent in when pressed with the finger as if full of cheesy matter. Nodular, irregular vesicles are the result of chronic inflammation, in consequence of which there has been a retention of vesicular secretion. Localized thickenings in certain parts of the vesicles are due to stricture or scar tissue; they may also be due to tuberculosis. Small vesicles, hard and irregular, are the result of chronic inflammation and partial destruction. If this destructive process goes on still further, they will probably atrophy until they cannot be felt.

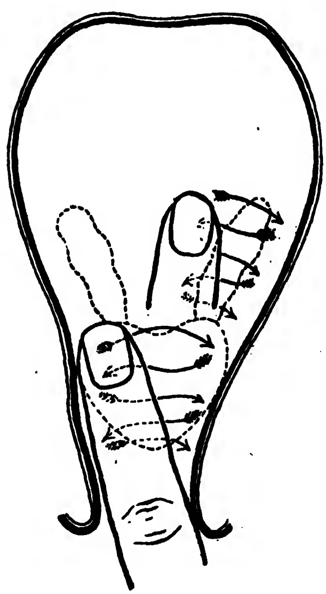


Fig. 240.—Massage of the Prostate. The arrow shows the direction in which the tip of the forefinger moves in this maneuver.

Third Urine.—During the examination of the prostate and vesicles, the organs are gently massaged with the finger (Fig. 240). When the finger is withdrawn, the patient is instructed to void the remainder of his urine in a third cylinder. This third urine represents the contents of the bladder plus the material massaged from the prostate and the vesicles into the posterior urethra. We are now ready, with the three cylinders of urine before us, to compare them and to draw such conclusions as may be warranted from their appearance.

The first urine contains the washings of the urethra plus any elements from the kidney, ureter and bladder that may be present. The second urine represents that from the bladder, ureter and the kidney alone, as all the products of inflammation that were present in the urethra were washed out by the first urine. The third urine, as we have seen, contains, in addition to the second urine, the elements massaged from the prostate and vesicles.

The urines are then sent to the laboratory for examination.

PLATE VI

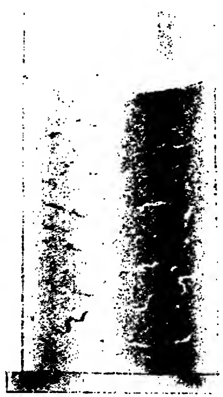


Fig. 1.

Fig. 2.

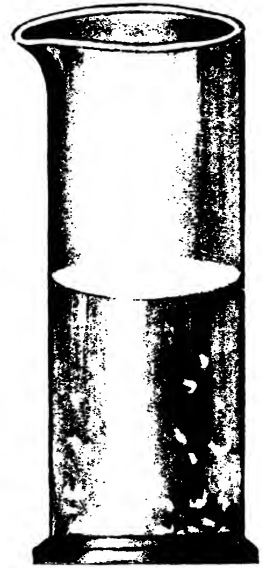


Fig. 3.

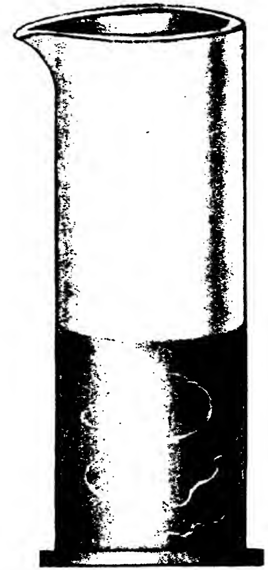


Fig. 4.

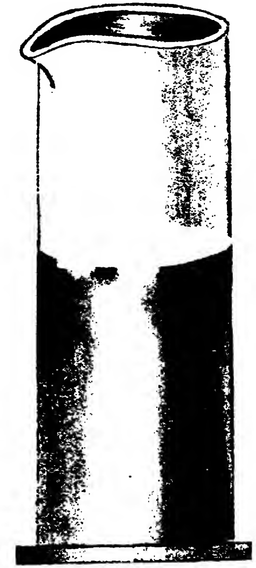


Fig. 5.

SHREDS AND FORMATIONS PASSED IN THE FIRST URINE WITHOUT MASSAGE.

Fig. 1.—Numerous fine shreds of different sizes, principally from the anterior urethra, in cases of chronic urethritis in the process of healing.

Fig. 2.—Numerous small fine shreds and a few large thick pieces, coming principally from the posterior urethra. The small comma-shaped shreds are most common in this part of the canal. The thick pieces at the bottom come from irregularities, depressions and pockets in the prostatic urethra, due generally to former prostatic abscesses. They are most abundant after massage.

Fig. 3.—Thick, lumpy shreds, resembling very coarse meal, in cases of chronic urethritis, and coming principally from the bulbous and posterior portion of the canal in chronic urethritis.

Fig. 4.—Long slender shreds, supposed to come from the ejaculatory ducts, in chronic urethritis.

Fig. 5.—Floating masses of semen, nearly all prostatic fluid passed with the first urine. They are seen often in cases of prostatorrhea and catarrhal prostatitis, and also when there are no symptoms of genito-urinary trouble and the patient is passing normal urine.

Examination of the Urines.—The following table represents the chief possibilities encountered in examining the three urines at the time the patient passes them and indicates in each case the significance of the findings.

	First Urine.	Second Urine.	Third Urine. (*After massage of the prostate.*)	Summary. (*What they show; parts involved.*)
(1)	Clear.	Clear.	Clear.	Normal urine.
(2)	Clear.	Clear.	Slightly opaque, with débris.	Prostate.
(3)	Clear (small floating mass, clear)	Clear.	Slightly opaque, with débris.	Prostate and vesicles.
(4)	Clear, with heavy shreds.	Clear.	Clear.	Chronic urethritis.
(5)	Turbid, heavy shreds.	Clear.	Clear.	Chronic urethritis.
(6)	Clear, heavy shreds.	Clear.	Cloudy, with débris	Urethra, prostate and vesicles.
(7)	Turbid, heavy shreds.	Clear.	Opaque, débris.	Chronic urethritis, prostatitis, vesiculitis.
(8)	Turbid, no shreds.	Turbid.	Turbid, no débris.	Pyuria, bladder kidney or both.
(9)	Turbid, with shreds.	No shreds or flocculi, turbid.	No débris, turbid.	Urethra, bladder, kidney or both or phosphaturia.
(10)	Turbid, shreds.	Turbid, shreds and flocculi.	No débris, turbid.	Urethra, bladder or kidney.
(11)	Turbid, shreds.	Turbid, shreds.	Turbid, with débris.	Urethra, bladder possible, kidney possible, prostate or vesicles, phosphaturia.

This table is quite difficult to understand. We should first eliminate phosphaturia. If the urine is turbid, therefore, a small amount is poured into a test-tube and a little acetic acid is added. If the turbidity is due to phosphates, it will at once disappear. This test should be performed whenever both the first and second urines are opaque.

If the urine does not become clear with the acid, another portion of it is poured into a test-tube and is shaken with some liquor potassæ. If the turbidity is due to pus, a thick coagulum will form and sink to the bottom, leaving a clearer upper portion.

In order to differentiate between inflammatory products massaged from the vesicles and those obtained in the third urine from the prostate, we should note the following points:—

URETHRA:

Urethral shreds.

PROSTATE:

(1) *Plugs* or *comma-shaped bodies* are from the mouths of the ducts.

(2) White thick masses in turbid urine, coming from the dilated and chronically inflamed ducts.

VESICLES:

(1) *Sago bodies* consist of the coagulated secretion of the vesicles that have become molded in the convolutions of the vesicles.

(2) *Sugar granules*, amber colored (or colorless) bodies resembling sugar granules. Of the same material as the sago bodies but firmer in consistence, not so abundant and smaller.

(3) *Spermatozoa*, alive or dead, whole or in broken pieces.

(4) *Plugs of pus coagula* mixed with epithelia from the vesicles.

(5) *Membranous flakes* that resemble small pieces of skin or membrane looking like egg membrane, white in color, consisting of a deposit on the walls of the vesicles, of sufficient thickness to come away in pieces.

(6) *Snowflakes*, light particles resembling snowflakes, not as heavy as the larger flakes. These are recent deposits which have not become formed as a membrane.

The different formations from the vesicles are probably composed of the same material, principally globulin, and differ mainly in the length of time that they have been secreted and deposited on the mucous membrane of their walls; in the quantity in which they have been secreted; whether suddenly in large amount, or slowly in small quantity; and whether the secretion is pure or mixed with large amounts of epithelia, spermatozoa, pus and other products of inflammatory exudate. After massage and after being allowed to settle in a glass alone or mixed with prostatic fluid, or urine, they lose the characteristic shapes that they have on escaping and become a blended gelatinous deposit. At times, casts of the vesicles are passed after massage, an inch or more in length, from one or both vesicles. The casts may be of sufficient size to block the urinary stream. It is hard to understand how masses of this size can escape from the ejaculatory ducts, for I have seen them of the size of a leech, so that for a moment the patient's urine would stop and the mass would suddenly be expelled with force, followed at once by the remainder of the urine.

Urethral Examination (*the Patient on the Table at Full Length*).—In examining the urethra, I stand on the patient's right. The urethra is first palpated by holding the penis in one hand and palpating the outside of the canal with the thumb and forefinger of the other. In this way, a follicular induration or inflammation, associated with a urethral follicle, a periurethral abscess, scar tissue, a foreign body or stone in the canal, may be detected.

The canal, unless it is acutely inflamed, is then examined with instruments: bougies à boule, sounds, catheter or filiform. I first sponge the meatus with a cotton ball soaked in bichlorid 1:1,000, then take in my right hand a bougie à boule (Fig. 241) about the size that I think will just enter the meatus. I dip its end into a bottle of glycerin and steady the organ with the fingers of the left hand placed on either side of the corona. I then insert the instrument through the meatus. In case it will not enter, I take up smaller ones until I find one that will pass in easily. If the first instrument passes easily, I go up the scale until I find the largest that will go to the bulb. I register the number of the instru-

PLATE VII

FIG. 1.

FIG. 2.

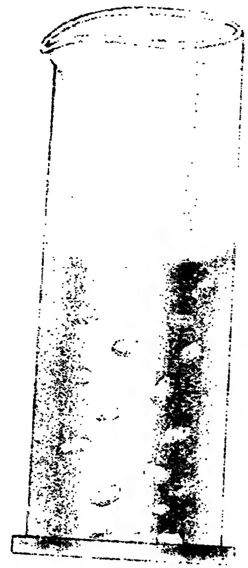


FIG. 3.

FIG. 4.

FIG. 5.

FORMATIONS COMING FROM THE VESICLES AFTER MASSAGE.

FIG. 1.—Large amount of detritus, light in texture, resembling snowflakes, coming from the vesicles with elastic walls. In the bottom a lump is seen which represents the casts of both vesicles.

FIG. 2.—Formations in the urine resembling pieces of membrane or skin, coming from the wall of atonic inelastic vesicles in chronic vesiculitis.

FIG. 3.—Formations resembling tapioca, coming from vesicles with fairly elastic walls in chronic vesiculitis. They are not frequently seen.

FIG. 4.—Formations resembling small sago bodies, coming from the vesicles in chronic vesiculitis of a milder type.

FIG. 5.—Formations resembling sugar granules, coming from very mild cases of chronic vesiculitis.

ment that passes the narrowest point or points of the canal and the distance of these narrowings from the meatus.

I then take a sound corresponding in size to the bougie à boule, with a short beak, and pass it into the urethra following the upper wall. If this glides easily into the bladder, I register "Urethra No. — at meatus" or whatever distance from it the narrowing may be and add "Sound No. — passes easily into bladder."

In case the smallest bougie à boule (No. 6 French) does not pass to the bulb or that a sound of that size does not pass through the remainder of the urethra, the locality of the impediment must be registered. It will then be necessary to pass a smaller instrument—a filiform bougie No. 1 or No. 2 (Fig. 242).

If the filiform passes the point of narrowing at which the larger instrument failed to pass, it will be spoken of as a filiform stricture. In case the filiform fails to pass, the impediment will be spoken of as an impassable stricture.

When the patient passes a fairly good stream and yet a filiform cannot be passed, the location of the impediment must be considered. If it is in the deep or bulbous portion of the urethra, the instrument may have entered a pocket, in which case, by inserting a filiform with a spiral end like a No. 2 and rotating it slowly during its introduction, the end may pass along the urethra by the pocket without sliding into it. In case the impediment is in the posterior urethra and the remainder of the canal is larger, it is probably not a stricture, but an enlarged or deformed prostate. If the patient is an old man, the condition is

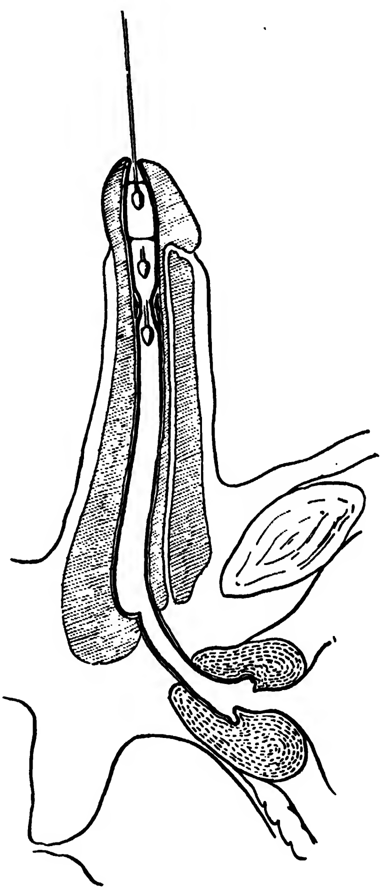


FIG. 241.—THE BOUGIE À BOULE MOVING DOWN THE URETHRA THROUGH A STRICTURED AREA.

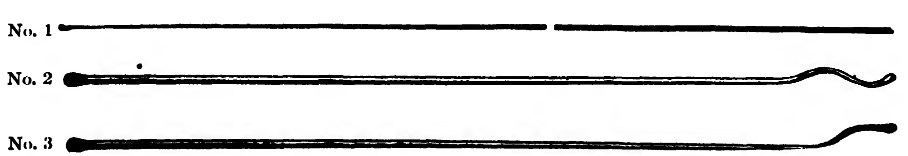


FIG. 242.—FILIFORM BOUGIES.

No. 1, straight. No. 2, with a spiral end. No. 3, with a bend near the end.

probably hypertrophy and a small coudé catheter would pass over the impediment and into the bladder: while if the patient is a young man who has had a bad attack of prostatitis, the impediment would probably be the result of a prostatic abscess, a cavity or an irregularity which prevents the entrance of the instrument. As these conditions are usually in the floor of the urethra, a coudé catheter which tends to hug the roof of the canal may pass through into the bladder. At times the anterior urethra is of large size with smooth walls and the sound goes up against an impediment at the bulb or at the neck of the bladder. In such a case, we must think of a spasmodic stricture of the cut-off muscle, dependent on an inflamed condition of the prostate or prostatic urethra in the first instance, whereas, in the second instance, of spasm of the vesical sphincter due to an inflammation of the bladder neck. In such cases, an instillation of cocain solution, or nitrous-oxid anesthesia, may be used in the examination. If nothing can be passed through a urethra under anesthesia and the patient is able to pass some urine although he has symptoms of urinary obstruction, no further examination can be made in his case excepting of his urine, and he should be sent to the hospital or home for further observation. A few days' rest in bed under a treatment of hot sitz baths, diluents, a liquid diet and a large amount of water, will probably so change the character of the impediment as to allow some instrument to pass. Such cases represent, however, a minority of those which come to our office. The majority of the cases have urethras of a fair size, that is, over 15 French.

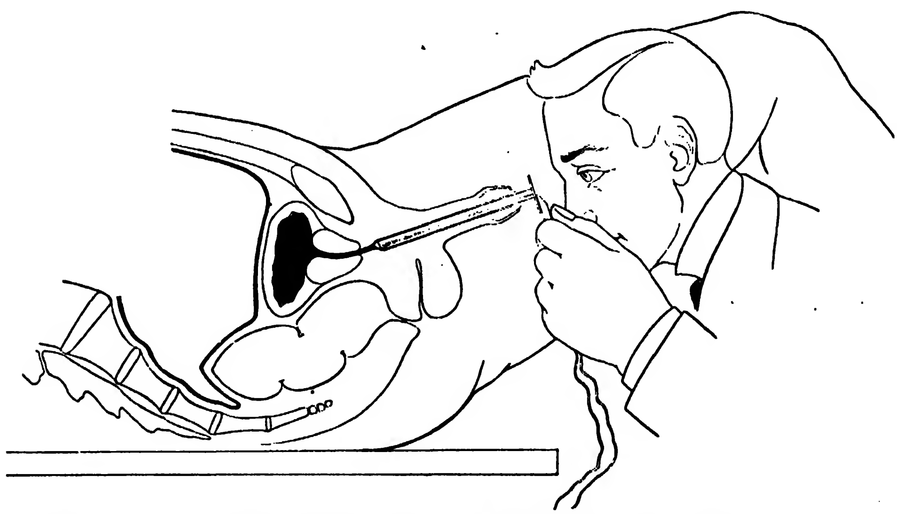


Fig. 243.—The Examiner Looking through the Urethroscope at the Urethral Bulb.

If the patient has but a slight chronic urethral discharge and the canal is over 20 French in size, the urethroscope is frequently used at the first visit, especially with patients from out of town or those who are accompanied by their physicians.

In this case, the urethroscope (Fig. 243) is dipped into glycerin and introduced in the same way as a bougie à boule. The mandrin is then withdrawn and a cotton swab is inserted to dry the interior of the tube and the urethra. A light carrier is then introduced and connected with the rheostat on the wall at the side of the table. By this means, polypi, ulcers, erosions and granular patches can be seen and noted on the history card. This particular instrument is, I believe, better than any of the other straight tubes for examining the posterior urethra, on account of the curve near its end, and it is tilted down and pushed gently in, hugging the upper wall of the urethra. If it is pushed in too far, it will enter the bladder and a gush of urine will follow, in which case, it should be pulled down below the sphincter, when the flow will stop and the posterior urethra can be examined.

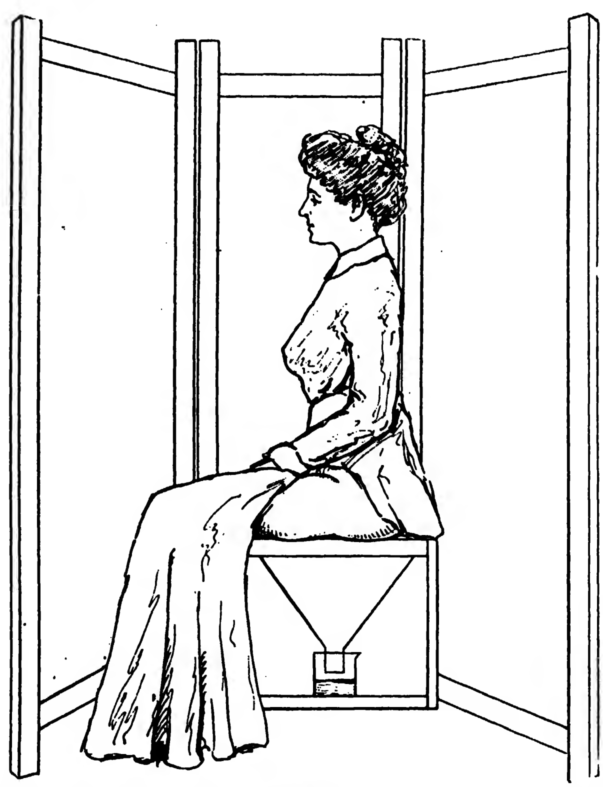


FIG. 244.—FEMALE PATIENT SITTING ON A COMMODE. A glass funnel is beneath the seat. Below the funnel is the glass cylinder.

Completion of the Examination in Women.—The first part of the examination in women, including the abdomen and external genitals, was concluded in the early part of this chapter. It now remains to obtain specimens of the urine and to examine the internal genitals. The patient is asked to step behind a screen and to seat herself on a commode and void urine (Fig. 244). The bucket of this commode has been removed and a large funnel put in its place, below which a glass is placed, in such a position that, when the patient voids the first urine, it enters the funnel and runs through it into the cylinder below. The nurse then removes it through a door in the side of the commode, places a second glass under the funnel and then asks the patient to pass the remainder of her urine. The nurse then carries the specimens to the examiner, who inspects the two specimens before sending them to the laboratory. If the first specimen is clear and there are no shreds, it will show that the urethra, bladder and kidneys are free from any marked suppuration. If the first is clear

with shreds and the second is clear without shreds, it will show a mild urethritis. If the first is turbid with shreds and the second is clear, it will show a more acute type of urethritis with no other involvement. If the first and second urine are both turbid, it will show pyuria or phosphaturia which can be determined by the rapid clinical tests of the examining room. If it is pyuria, the source of the pus will be determined by the laboratory examination.

The female patient is then returned to the table, where the examination of her internal genitals is continued. (See Fig. 236.) Her perineum is examined for lacerations and any cystocele or rectocele noted. The uterus is palpated to discover any laceration of the cervix, tenderness, induration, enlargement or displacement of the organ, free mobility or fixation or the presence of a tumor. The ovaries and tubes are then examined for tenderness, enlargement or displacement. Exudates of a varying degree, depending upon metritis or salpingitis, are of the greatest importance. The speculum is then introduced and the cervix inspected for lacerations, ulcerations, or the presence of discharge or hemorrhage. Uterine displacements or prolapse, fibroma or carcinoma, or adhesions due to inflammation of the adnexa, are all important on account of interfering with the functions of the bladder as well as predisposing to cystitis.

The routine examination of the urethra and bladder is the same in women as in men, although, in the former, the passing of instruments is much easier owing to the absence of the prostate gland. Urethral lesions are not so common in women as in men, but, although strictures are not usually looked for, they are more frequently present than is generally supposed.

Diseases of the bladder are not so common in women, the most frequent being tuberculosis. Female bladders, however, are much affected by the condition of the surrounding organs and often to a sufficient degree to give rise to the greatest suffering and inconvenience.

Records.—With each history chart, is filed the diagram of the urinary tract represented in Figs. 1 and 2 in the chapter on Anatomy, on which any lesions found are marked so as to be visible at a mere glance. These diagrams were made from a dissection, made at the New York Post-Graduate School (Guiteras, *Philadelphia Medical Journal*, June 2, 1900).

The examination having been completed and a tentative diagnosis made, the line of treatment indicated is recorded on the back of the card and changes made on subsequent visits are appended. If an operation is performed, it is described and a pathological report of anything removed is added.

The report of the urinary analysis made from a twenty-four hours' specimen is also attached to the history card represented in the chapter on The Urine.

The entire documentary record of the case, including copies of the correspondence with the patient or with the family or physician, is filed in an envelope in a vertical filing case, in alphabetical order. In this way anything pertaining to each case is instantly available for investigation.

CHAPTER XVI

UROLOGICAL THERAPEUTICS

In the treatment of patients, the first thing that is expected of a physician is a prescription for medicine; in fact, it seems to be the general idea that every symptom indicates a disease that should call for a specific drug. It is true that there are certain drugs that are specific; but in urology proper, no drug has yet been found that can be considered as such. It seems, in this branch more than any other, that it is important to keep the patient in the best physical condition by regulating the diet, digestion, bowels and the amount and variety of exercise in those who are up and about; to protect the surface of the body by suitable clothing; and to keep the function of the skin as perfect as possible. Drugs should be prescribed to assist nature when functions of certain parts are at fault; to reduce congestion and inflammation when necessary; to stimulate when the tissues are weak; and to counteract and destroy infections.

DIET

Diet is one of the most important factors in treatment. Many people suffer through errors of diet. A visit to health resorts, where people are cured simply by leading a regular life, resting or exercising, according to the case, following a simple diet and drinking a certain water, or bathing—*without taking a drug*—is a strong argument in favor of the fact that drugs are not always necessary.

Simple Diet.—Simple food that is easily digested and assimilated, and does not give rise to irritating by-products, is then a most important remedy in the treatment of disease and especially in urology. A milk diet alone, or combined with some mild alkaline water, is the simplest of all diets. Such a one should be prescribed in acute nephritis, the severest of all diseases of the urinary tract. It should also be ordered in chronic nephritis, when uremia is threatened or present. It can be prescribed to patients suffering from acute parenchymatous prostatitis and in prostatic hypertrophy, or in stricture cases, when retention is present, due to congestion. It is also recommended in all complications due to infections of the urinary tract.

Simple diet for the patients who are up and about their regular pursuits of life, is quite liberal. In this case, fruit, cereals, bread, eggs, milk, fish and shell-fish, meat, green vegetables, salad and cheese are regarded as simple diet. It

is only necessary to eat in moderation food simply prepared; to take a variety rather than too much of any one kind; to see that the food is prepared in a simple and digestible manner; to avoid stimulants, condiments and rich dishes.

I think that most of us would be in better condition if we ate nothing fried, nothing sweet, no condiments and did not use alcoholics, tea, coffee, or tobacco, but such would hardly be practicable in our present manner of living.

Fruits.—Fruits should be eaten at the morning and midday meals, rather than at the evening repast. For breakfast, orange, cantaloupe, peaches, baked apple and grape fruit are preferable; whereas, for the midday meal, any of the same varieties can be used, as well as apples, pears or plums. No sugar should be eaten on the fruit.

I do not consider berries healthful, as they frequently irritate the intestines, especially strawberries, although some consider this mechanical irritation good in case of constipation.

Stewed fruit is considered healthier than raw, but is usually too much sweetened.

Cereals.—Cereals are usually taken at the morning meal and eaten generally with cream and sugar. They are often rich in starch and oils, and are made richer by the addition of sugar and cream. Personally, I think it is a mistake to put cream and sugar on cereals, and that it is better to use salt and milk. I do not look upon cereals as a necessary breakfast food, but if they are to be partaken of, I advocate those made from corn, barley, or oats, rather than the wheat products.

Eggs are the most nourishing and most easily digested of the nitrogenous foods that can be taken, and should be eaten either soft boiled, poached or shirred, for breakfast or lunch.

Bread.—Bread from the ordinary loaf is not advised, unless it is toasted a day or so after baking, when it is quite easily digestible. Thin French bread and rolls, with a large amount of crust and a small amount of crumb, are more easily digested. These can be heated in the oven for a few moments. Hot bread, that is, the bread freshly baked, which is composed mostly of the crumb, is most indigestible. Corn bread cannot be recommended, as it usually contains too much sweetening, for neither much shortening nor sweetening is well tolerated.

Coffee and Tea.—Coffee and tea are stimulating in the morning and have a good effect upon the heart and circulation. Their active principle—caffein—is a powerful stimulant and diuretic; but it is a question whether it is not injurious to stimulate the heart and blood vessels three times a day, as persons so frequently do.

I do not recommend the use of tea and coffee. If taken for breakfast, mild *café au lait*, made by adding one tablespoon of freshly ground coffee to half a pint of hot milk at the point of boiling, made in a French drip coffee pot, is sufficient. The hot milk is usually poured through twice; no water need be

used in its preparation. Such a preparation is much more nourishing than a cupful of coffee with a small amount of cream. If taken after dinner, a small cup of black coffee is sufficient.

Fish, Meat and Vegetables.—Fish, meat, vegetables and greens should be taken at the midday and evening meals. For health and good digestion, I think that it is better to take a heavier meal in the middle of the day, as the lighter meal in the evening would be more easily digested and, consequently, would not interfere so much with sleep. In city life, however, especially in those who do active brain work, the midday meal should be lighter. I believe that two meals a day are better tolerated than three, when taken one at 10 or 11 A.M., and the other at 5 or 6 P.M.

SHELLFISH, as oysters and clams, are good for lunch and dinner. They are more easily digested raw, except the so-called soft clams, which are better steamed, stewed or baked.

SOUPS.—*Consommé* is good in a light diet and at the beginning of a lunch or dinner. Heavier soups may be eaten at dinner, but bisque and creams are not recommended.

FISH.—Fish should be eaten broiled, boiled or baked. The broiled fish is the most palatable, but boiled fish is very delicate if properly cooked. Fish is more easily digested than meat, especially fish of the smaller varieties—that is, weighing less than four pounds. It is a good luncheon food, if the midday meal is lunch, or equally good at dinner. It should not be taken with white or any rich sauces. A small amount of butter sauce is the simplest and best. The fish most recommended are sea bass, weak fish, blue fish, black bass, trout, Spanish mackerel, sea trout, white fish, flounder, sheepshead and pan fish.

MEAT.—Meat should be taken in a moderate quantity. I do not believe in eating meat for breakfast, but think it better for the midday or evening meal. It is a question how often meat should be eaten. Personally, I think that once a day is sufficient, but if partaken of moderately, twice a day is not too often.

In eating meat, it is well to take a variety rather than to confine oneself to any particular kind for everyday consumption. It is perhaps difficult to define the meaning of meat, but the flesh (that is, the muscle) of animals and birds, is generally considered as such, whereas, the internal organs are not, strictly speaking, meat. If, then, we accept the classification of meat in its widest scope, we have in beef, steaks of different cuts, also broiled, roast, stewed, braised and boiled beef. In mutton, veal, pork and animal game, we have certain large cuts to roast and boil, whereas the cuts representing steaks, are called chops or cutlets.

The crisp, rich fats that are on the outside of roasted and broiled meats, although agreeable to the palate, are not tolerated by the stomach and should not be indulged in freely.

In the bird family, we have turkey, goose, duck (domestic and wild), fowl, chicken and squabs; also game birds, as quail, partridge, grouse, woodcock and plover. All of the poultry and game birds are usually roasted, but some of the poultry is at times boiled, while the smaller game birds are split and broiled.

The internal organs of animals and birds are also edible, as the liver and heart, the kidney, the pancreas and the thymus (sweetbreads), and stomach (tripe), as well as the brains in animals and the gizzard in birds. These can be cooked in various ways, but are not healthy with rich sauces. They are generally not as difficult to digest as the muscle flesh is. The preparation of meat food in this class should be in the most easily digestible way and they should never be fried.

Vegetables.—The vegetables recommended in the simple diet are, in the first class: string beans, green peas, rice; in the second class: spinach, cauliflower, Brussels sprouts and potatoes; in the third class: green corn, shelled beans, onions, beets, cabbage and tomatoes.

Potatoes are a staple article of food, but rich in starch. They should be eaten only once a day, baked or mashed. Good rice is one of the most wholesome and easily digested articles of food and should be boiled in such a way that the grains are separated and it is dry and not soggy.

Salads.—Salads made of greens are recommended. They should be eaten at the principal meal of the day. The varieties to be preferred are lettuce, chickory and romaine, served with a French dressing containing but little vinegar and pepper: one part vinegar to four parts of oil, salt and a very little freshly ground white pepper.

Cheese.—Cheese should be eaten sparingly. The Stilton, Edam, Swiss, Port Salut, Brie and cream cheeses are recommended.

Sweets and Desserts.—Sweets are unnecessary and not recommended. The least harmful are the sago, rice, tapioca and farina puddings, with very little sweetening.

Alcoholic Beverages.—Alcoholic drinks are contraindicated in all cases of urinary diseases and yet, if a patient is below par or septic, they are often given. Beers and ales should be omitted in all cases, but light wines and spirits can be given in moderation. From one to two ounces or more of whisky a day can be allowed in certain cases of chronic nephritis and tuberculosis, while in septic cases, more can be given. A light Bordeaux wine (claret alone or mixed with water) can be allowed in almost any case excepting in acute nephritis or acute urethritis, and is frequently recommended in cases of chronic cystitis. It should be limited to eight ounces a day. A light Moselle or Rhine wine is also used in some chronic cases. This list is considered very moderate and much larger quantities are frequently taken habitually or on special occasions.

Diet at Various Meals

Breakfast.—I do not think that fish, meat or vegetables should be taken for breakfast, as more effort is required to digest them. Cereals are too heavy for many people, and fruit too full of acids and sugar. I believe that *café au lait* with rolls or toast is sufficient for the morning meal. If, however, this is not found to be so, two eggs and fruit can be taken. When the period between the morning and midday meal is a long one, cereal may be added.

Midday Meal.—The amount to be taken at the midday meal depends very much on what has been eaten at breakfast. If that has consisted of simply a cup of coffee, milk and rolls, then fruit and eggs can be added to this second meal, although fruit may always form part of the lunch.

In addition, lunch, as I have said before, can consist of oysters, or clams, *consommé*, fish, meat or internal organs, vegetables and cheese.

Dinner.—The bill of fare for dinner may contain the same dishes as the lunch with, perhaps, a heavier soup, a roast, instead of broiled meat, and a salad. Eggs are not considered a dinner food and fruit is not desirable.

Entrées are frequently not understood by people in this country who live away from the centers influenced by French cooking. The preparations known as *entrées* are stews of beef, mutton or veal; meat, poultry and game cooked in the casserole; tenderloin of beef roasted or cut into small steaks and broiled; saddle of mutton, rib or loin chops; sweetbreads, kidneys, brains and tripe. They are usually cooked with or served with some vegetable. I simply mention a few of the most common on account of lack of space.

The different varieties of animal and vegetable food already mentioned, can be selected from. It is well to eat sparingly and not to think that all of these articles should form part of each meal.

It must be remembered that these are guides to simple food for people who have slight trouble with the genito-urinary tract, but are attending to their regular work. They can be modified accordingly.

At one of the hospitals at which I am attending, the diet list shows what is given to patients. All the special diseases have carefully selected diets that will be found under that particular division.

Hospital Diet

Fluid Diet:—Milk, broths, bouillon, milk punch, eggnog, egg lemonade, egg albumen, beef juice, strained gruels, cocoa, cocoa shake, kouniss, matzoon, liquid peptonoids, lemon and wine jellies.

Soft Diet:—Soups (without vegetables), oysters, all cereals, milk toast, eggs (soft boiled or poached), milk puddings, ice cream, scraped beef, toast, junket, tea, coffee, cocoa, milk.

Light Diet:—In addition to the above: Chicken, chops, baked potatoes, baked apples and fresh fruits.

For Ward Patients

Breakfast:—Tea or coffee, milk and sugar, cereal, one half pint of milk, bread and butter, meat or eggs.

Dinner:—Soup, meat, potatoes, one vegetable, bread and butter, one half pint of milk, dessert. (Special diet, chicken, chops, broth, etc., from diet kitchen.)

Supper:—Tea, milk, sugar, bread, toast and butter, stewed or fresh fruit. (An extra, meat, eggs, broth, rice, etc.)

For Private Patients

Breakfast:—Tea and coffee, cereal, rolls, bread and butter, potatoes, meat, fruit.

Luncheon:—Tea and coffee, bread and butter, meat and *entrée*. (Remainder as ordered. Specially prepared delicacies from the diet kitchen as broth, birds, jellies, oysters, etc.)

Supper:—Tea and coffee, bread and butter, soup, meat, oysters, vegetables, dessert.

Wards (Complete)

FOR PATIENTS IN PUBLIC WARDS

Regular Diet

Breakfast	*Dinner*	*Supper*
Tea, coffee, milk and sugar, cereal, one half pint milk, bread and butter.	Soup, potatoes, bread and butter, one half pint milk.	Tea, milk and sugar, bread, toast and butter, stewed or fresh fruit.

In addition

Sunday

Oatmeal, eggs.	Roast beef, extra vegetable, baked custard.	Oyster or clam stew, cake.

Monday

Hominy, steak.	Beef stew, extra vegetable, bread pudding.	Cold meat, scrambled eggs.

Tuesday

Breakfast	*Dinner*	*Supper*
Oatmeal, liver and bacon.	Roast beef, extra vegetable, sago pudding.	Boiled Indian meal.

Wednesday

Oatmeal, steak.	Roast lamb, extra vegetable, rice pudding.	Gingerbread.

Thursday

Hominy, eggs.	Roast beef, extra vegetable, cornstarch pudding.	Boiled rice and milk.

Friday

Oatmeal, fish.	Fish or roast lamb, vegetable, bread pudding.	Milk toast, canned fruit.

Saturday

Oatmeal, minced meat.	Mutton or beef stew, vegetable, cottage pudding.	Corn bread.

Special Orders from Diet Kitchen:—Chops, chicken broth, oysters, birds, etc., jellies and custards.

Peptonized Milk (Cold Process).—Into a clean quart bottle, put pancreatin, gr. v, and sodium bicarbonate, gr. xv and one teacup of cold water. Shake and add a pint of fresh cold milk. Shake mixture again and immediately place on ice. When needed, shake the bottle, pour out required portion and replace on ice.

If the warm process is ordered, prepare as above, but set bottle in water just so hot that the whole hand can be held in it without discomfort, about 115° F.; keep the bottle there ten minutes. Then put on ice at once to check further digestion and keep milk from spoiling.

Nutritive enema:

Peptonized milk .... ℥vj;
Egg (beaten) .... No. 1.
Salt, pinch.

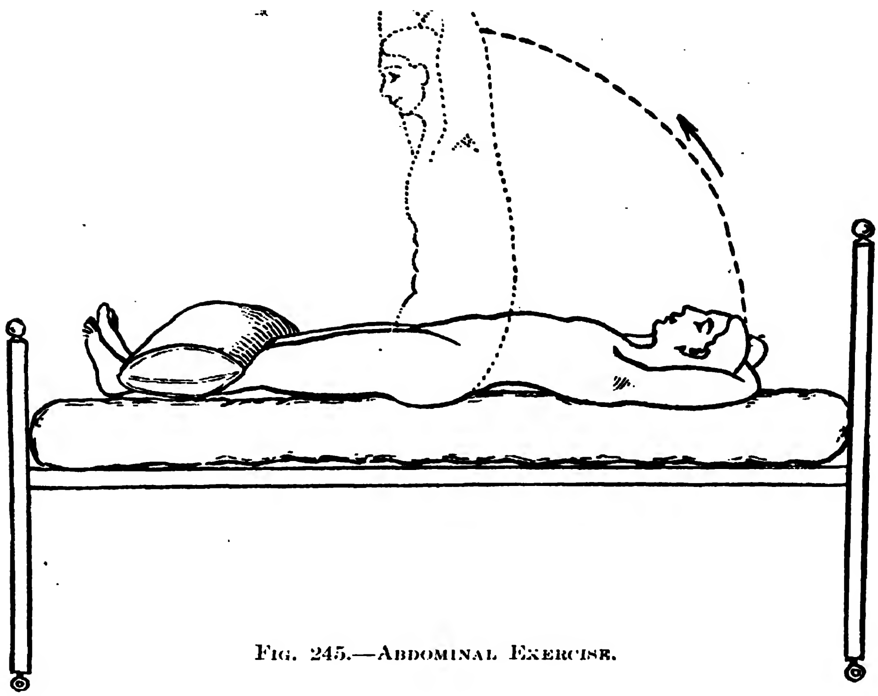


Fig. 245.—Abdominal Exercise.

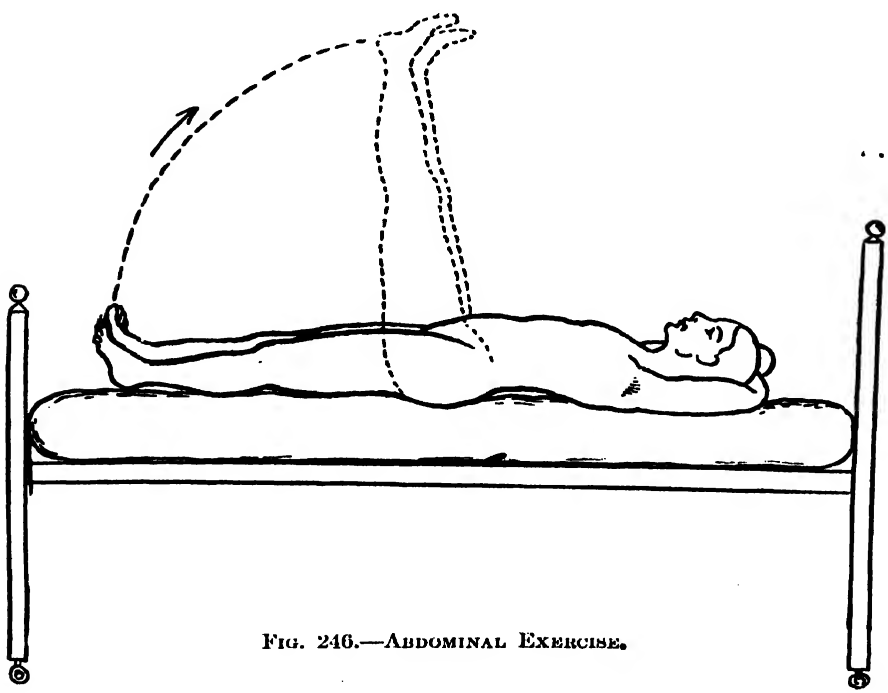


Fig. 246.—Abdominal Exercise.

EXERCISE

One of the most difficult problems that we have to contend with is how to keep our walking patients healthy by means of proper exercise. In the mad rush of daily work in our large cities, but few patients will take the time during the day to go through the prescribed exercises, especially those in the open air, which are exceptionally beneficial. Very few people exercising at home care to go through many movements and therefore as short a list as possible should be prescribed for them. We must, therefore, endeavor to have them take some exercise before beginning the day's work. The most convenient time for this seems to be in the morning on arising, preceding the morning bath.

The exercises prescribed by me are those which bring into play and strengthen the muscles of the abdomen, back, loins and thorax. For home exercise I believe the pulley weights are the best for this purpose, beginning at first with the lighter weights and gradually increasing them in proportion to the increasing strength of the individual.

The **abdominal exercises** are taken as follows: Lie flat on your back in the bed before arising, throw the bedclothes over the foot of the bed and the pillows over your feet. Then clasp your hands behind your head and come to a sitting posture fifty times or more with the legs stiff. Then kick aside the pillows and bring up the lower extremities, held stiff, until they are at right angles with the body, for the same number of times. Usually the patient is only able to make these movements a few times at first, but the number is easily increased as the abdominal muscles strengthen.

Fig. 245 shows exercise in bed, the patient lying flat with the hands behind the head and the legs stiff, bringing the body to a sitting posture.

Fig. 246 shows the same position with the body and legs stiff, bringing up the legs and feet to right angles.

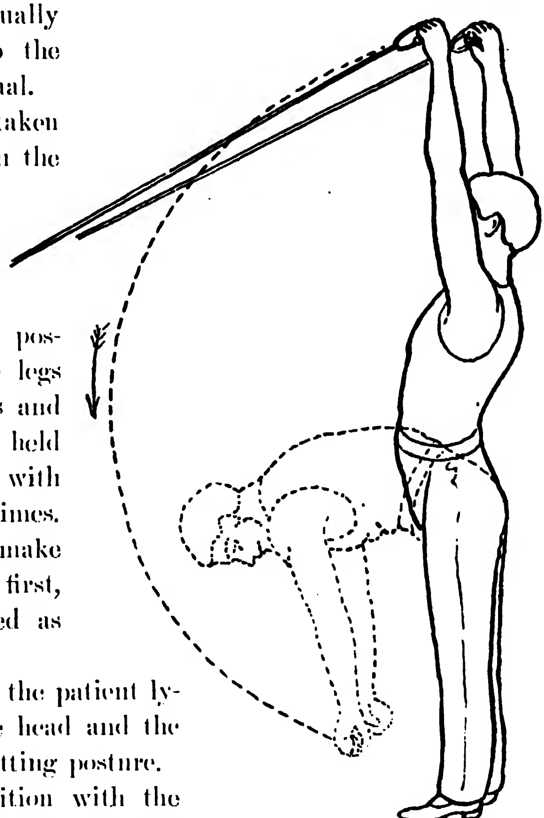


FIG. 247.—BACK EXERCISES.

Pulley-weight Exercises.—The pulley-weight exercises recommended are:

First.—Stand erect, facing the pulley weights, with the arms extended toward them (Fig. 247). Bring the arms, extended and stiff, down so that the

hands will reach the feet as nearly as possible without bending the knees. Then swing the arms, still stiff, over the head as far as possible until the back is bent. This swing from the lowest position to which one can reach to the highest is good for the muscles on the front of the chest and abdomen and those of the neck and shoulders.

Second.—Stand erect, with the back to the pulley weight, with the arms extended away from the weights, then allow the arms to drop to the sides until

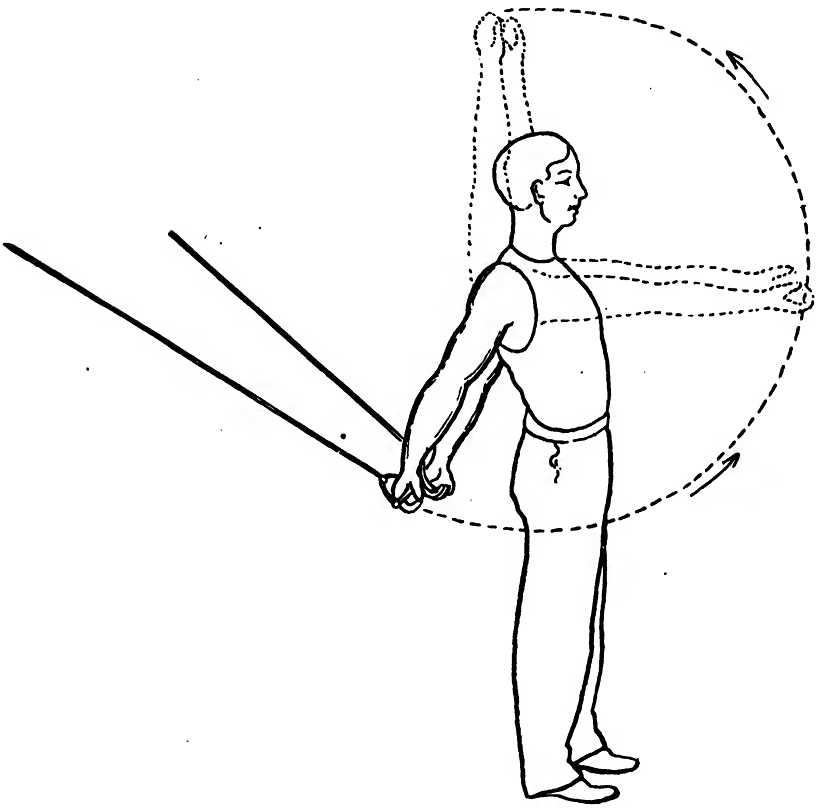


FIG. 248.—FRONT EXERCISES.

the hands are as near the pulleys as possible. Sweep the arms forward to a right angle with the body and upward and backward as far as you can (Fig. 248). From this point of extension, bring them down again to the position already referred to. This swing is beneficial to the muscles of the front of the chest and arms, the back, the shoulders and the back of the arms.

Third.—Stand with one side toward the pulley weights. Grasp the handles with either hand, both arms extended toward the pulley weights, one from in front and the other from behind the body (Figs. 249 and 250). Both arms are then extended as far away from the pulley weights as possible, on the other side of the body, until at right angles to the side of the body. The arms and

hands then go back to the original position and the movement is repeated. After making the desired number of movements, the other side of the body is turned

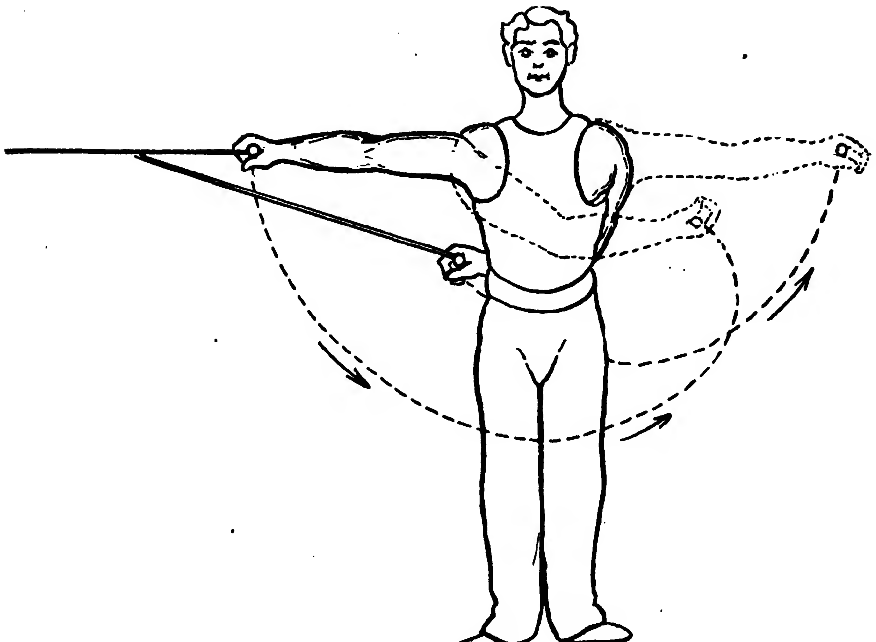


FIG. 249.—CHEST AND ARM EXERCISES.

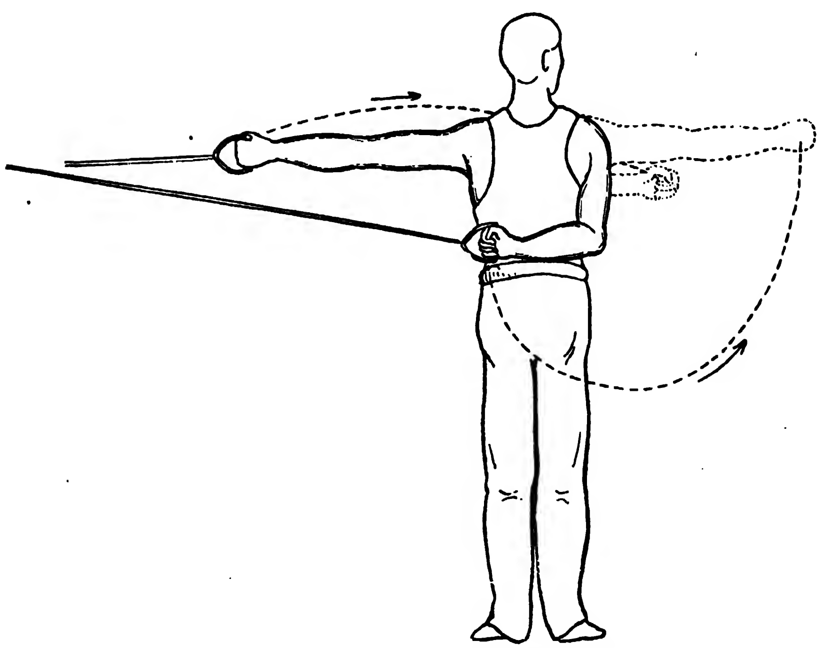


FIG. 250.—CHEST AND ARM EXERCISES.

toward the pulley weights and the same movements are made, thus giving the same exercise to both sides.

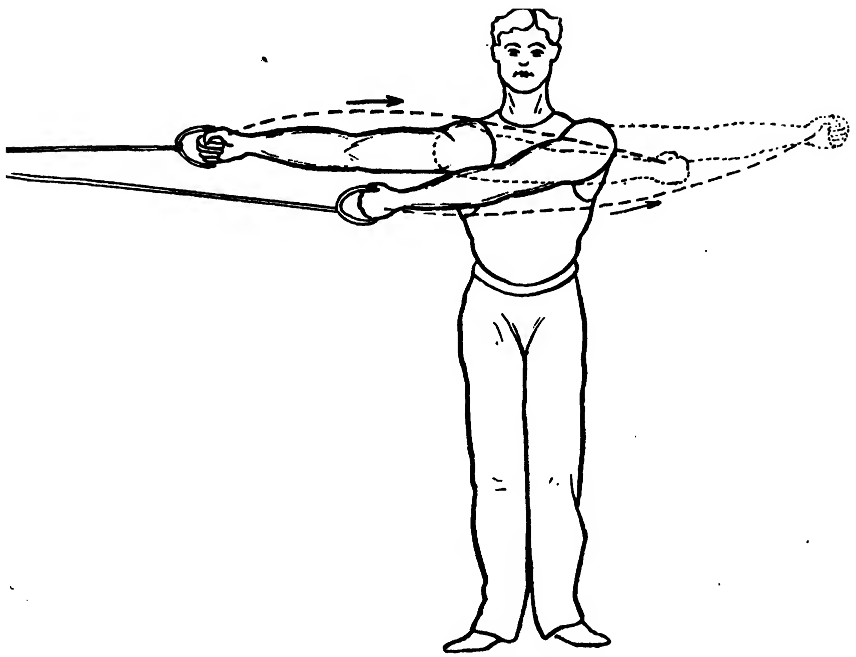


Fig. 251.—Chest and Arm Exercises.

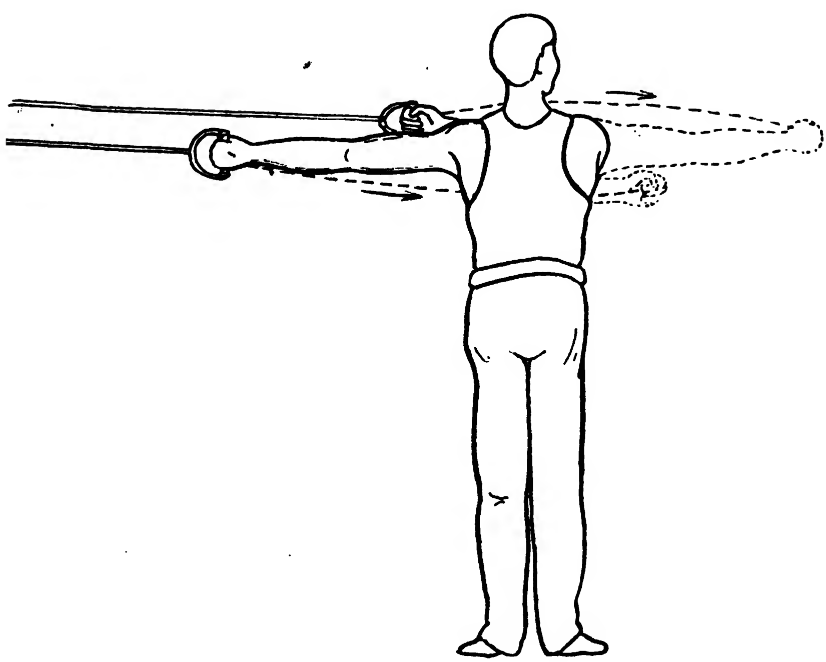


Fig. 252.—Chest and Arm Exercises.

The muscles brought into action are those of the front of the chest and arms, the back and the muscles around and between the shoulders.

Fourth.—Stand with one side toward the pulley weights, as before. Extend both arms toward the pulley weights (Figs. 251 and 252). The arm next to the weights will be at full extension and at right angles to the body. The arm away from the pulleys will be slightly bowed over the chest. Then swing the arms held straight with no bend to the elbows around the front of the body, at right angles to the body, to the other side. The arm farthest from the weights will then be extended straight and the nearer one will be bowed over the chest. Repeat as many times as desired and then turn the other side to the weights and make similar movements.

This exercises the chest and abdominal muscles, the back, the muscles of the arm and under the arm.

Fifth.—Stand with the back to the pulleys and the feet about half a yard apart. The arms should be slightly flexed, the hands extending back toward the machine. One hand is then swung around in a circle in such a way that it passes by the front of the body at about the level of the shoulder, while, as it swings farther, it passes around the body to the other side until the knuckles point toward the wall behind. In making this swing, the body is raised on the ball of the foot on the same side, while the body turns at the waist (Fig. 253).

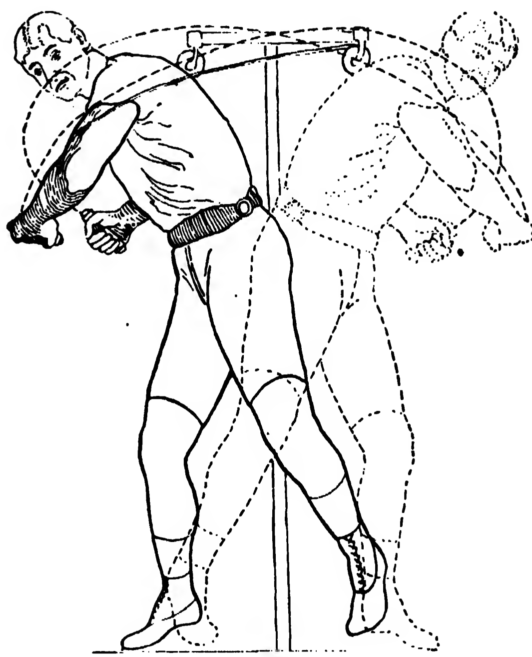


FIG. 253.—LOIN EXERCISES.

This is the best movement that can be used by walking urological patients in good condition. It exercises the muscles of the legs, thighs, buttocks, abdomen, loins, chest, shoulder, the muscles about the shoulder and the upper arms.

Outdoor Exercises.—Of the outdoor exercises, walking in the fall and winter, and rowing and swimming in the summer are the best. In walking, five miles is sufficient at a gait of from three and a half to four miles an hour. Golf, when one is properly clothed, is an excellent exercise, as it keeps one walking in the open air. In the city, walking to and from business each day is likewise beneficial.

Rowing and swimming are of great benefit, provided they are not too violently indulged in, or prolonged too much. Long exposure in the water is especially weakening.

Tennis is too violent for many, and horseback or bicycle riding is especially injurious. Dancing as an exercise is beneficial, if after the dance the patient will retire and change the underwear. Sitting in a draught after dancing and eating a hearty supper before retiring are not to be commended. Billiards and pool furnish a moderate and desirable form of exercise, as they require the player to walk around the table and stretch over it, at the same time keeping the mind occupied in a pleasant way.

THE CARE OF THE BOWELS IN UROLOGY

The care of the bowels is most important in urology, especially in diseases of the bladder, prostate and urethra. The venous circulation in the above-mentioned organs is very closely associated with the rectal plexus, in consequence of which a passive congestion in one would be associated with a passive congestion in the other, while the mechanical pressure of the feces would act as an irritant.

In patients who are up and about, this can usually be accomplished by regulating the diet and prescribing sufficient exercise. In patients who are in a weakened state from chronic disease, and in bed patients, this is more difficult.

The results of constipation are renal irritation due to indican and other irritating products in the urine; pressure on the prostate and vesicles, and, in consequence of this, congestion and frequency of urination; while later on, a neurasthenic condition may develop.

The diet in cases of constipation should have among other varieties certain articles that leave a residue as cereals, prunes, spinach, celery, green salad, fruit, etc. The remaining diet should be as usual.

The patients on arising should drink a large glass of water, then exercise for a quarter of an hour. (See prescribed exercises.) After this they should take a cold shower and a rub down. Breakfast should then be eaten, after which the patient should go to stool as a habit, whether he feels the desire or not. Coffee taken with breakfast also assists and many consider smoking a desirable adjunct.

When, however, the behavior of the bowels under the suggested treatment is not what is desired, certain laxatives should be given. These are of two varieties: waters and drugs. The best of the waters are Apenta and Carabaña, half a glass (4 ounces) of the former or a quarter of a glass (2 ounces) of the latter is sufficient to cause a movement when the patient is up and about. When the patient is in bed, 6 ounces of the Apenta or 3 ounces of the Carabaña should be given. The best rule for bed patients is to give them the aperient, to be followed in three quarters of an hour by a light breakfast with coffee and hot

milk. One hour after breakfast, if the bowels have not moved, an enema of soapsuds should be given.

Of the laxative drugs, cascara is the best. It is well to start in with the fluid extract, taking half a drachm every night, increasing or diminishing the dose accordingly. Some prefer to take this after meals in smaller doses, alone or mixed with other drugs. Of the intestinal laxatives having especial action on different parts of the tract, the best are podophyllin and aloin. The first has the better effect on the upper part of the intestine, the second on the lower bowel. Nux vomica and belladonna are good intestinal tonics. In presenting a combined tablet or pill, aloes, belladonna and nux can be used; or podophyllin, belladonna and nux; or extract of cascara mixed with one or all of them.

The doses for laxative use are:—Aloin, gr. $\frac{1}{6}$; ext. belladonna, gr. $\frac{1}{8}$; ext. nux, gr. $\frac{1}{4}$; ext. podoph., gr. $\frac{1}{8}$; ext. cascara, grs. 2.

If, in walking patients, the bowels do not move after breakfast with the aperient waters or drugs, a glycerin suppository can be introduced. This will usually induce a movement in from three to five minutes. In case it fails a 6- to 8-ounce bottle of Red Raven splits can be taken three quarters of an hour before the midday meal. For cases with acute pelvic trouble the aperient waters are the best and aloin is contraindicated.

For those who do not have pelvic trouble, cascara and other drug laxatives are the best. Purges can be occasionally taken. Castor oil (half an ounce in sarsaparilla) is given, if there is intestinal fermentation with frequent and unsatisfactory movements, and calomel, grs. 3 to 5, in other cases.

In preparing patients for operation, surgeons differ. Some give calomel or compound cathartic pill, followed next morning by magnesia sulphate, ℥ss, while others give simply licorice powder, and citrate of magnesia on the following day.

In giving calomel, it can be prescribed in $\frac{1}{10}$-grain doses every hour for ten hours; or $\frac{1}{4}$ grain every half hour for four hours; or $\frac{1}{2}$ grain every hour for six hours or 3 to 5 grains at one time. In any case, magnesia sulphate, half an ounce, or Apenta, 4 ounces, or Carabaña, 2 ounces, should be given on the following morning, followed by an enema.

After the operation calomel can be given with soda bicarbonate in any of the above doses, followed by magnesia, and, if the bowels do not move, by an enema of soapsuds. In nearly all my postoperative cases I prefer to give Apenta water from 4 to 6 ounces every morning and to follow it in three quarters of an hour by a coffee with milk, and toast breakfast.

WATER AND WATER DIET IN UROLOGY

Plain water is without doubt the healthiest beverage for mankind. The majority of city dwellers do not drink it as they should. In fact, a great many

of the city people drink tea, coffee, beer or ale with their meals, and nothing between meals, while many others drink iced water at meal times and between meals. Frequently clinic patients, when I tell them to drink water, answer that they do not like it and never drink it.

Water is rapidly absorbed into the blood, increasing the amount of fluid plasma, and is eliminated chiefly through the kidneys and the sweat glands. An increased amount of water taken daily flushes the kidneys and helps elimination through the skin. A normal person should drink about three pints daily, the exact quantity varying with the season, the amount of exercise and the weight of the individual.

Varieties of Water.—A number of varieties of water are used: (1) Distilled water, (2) rain water, (3) city water, (4) spring water, (5) well water, (6) mineral water. The purest of them undoubtedly is *distilled water*, and in the absence of a pure natural water this may serve for drinking. Next in purity comes *rain water*, which makes an excellent drinking water if collected in the country, or, if filtered to remove dust, in the city. *City water* comes from lakes and rivers usually at a distance, and is stored in reservoirs and led through aqueducts. City water not only is apt to be contaminated with germs, but also to contain unpleasant mineral constituents, giving it a peculiar taste or cloudy look; besides this, it may contain lime salts which render it "hard." Such water should not be drunk unless it is filtered and boiled.

Well water is apt to be polluted by sewerage unless the well is properly constructed with cemented brick walls and dug deep enough to avoid tapping contaminated water (over 30 feet as a rule).

Spring water is a pure and clear water which always contains more or less mineral matter and in reality is a mineral water. Spring water is derived from rain water which percolates through the ground until it strikes an impervious stratum (rock), when it flows along this stratum until it finds an outlet in an unevenly leveled spot.

Water Diet.—Two quarts of fluid should be taken daily, of which three pints should be water. Water should be taken as follows: one glass on arising; the second at 11 A.M.; the third at lunch; the fourth at 5 P.M.; the fifth at dinner and the last on retiring. The time when water is drunk makes a decided difference in its action. Water taken between meals on an empty stomach has a diuretic action and tends to make the drinker thin. Water drunk with the meals has no diuretic effect and tends to increase the drinker's weight. After operations on the lower urinary tract, the patient should drink large quantities of water. If he vomits it, more should be given. I often give a gallon of water during the first twelve hours after a prostatic operation.

Mineral Waters.—A mineral water, in the sense in which this term is used by physicians, is one which contains a sufficient amount of mineral matter to produce a distinct physiological action aside from that of the simple solvent or

drinkable quality water. In the strict sense, however, any water containing minerals, as spring water, is a mineral water. The classes of mineral waters used in urology are:

1. *Table waters:* Indifferent or neutral waters containing little mineral matter and acting, in virtue of their carbon dioxid, as a pleasant beverage.
2. *Alkaline waters:* Contain carbon dioxid, sodium and magnesium bicarbonates.
3. *Alkaline chlorid waters:* Contain in addition sodium chlorid.
4. *Earthy waters:* Charged with carbon dioxid, contain earthy carbonates and sulphates (calcium, magnesium).
5. *Alkaline sodium waters:* Contain sodium sulphate as chief ingredient; besides sodium bicarbonate and chlorid.
6. *Lithia waters:* Contain lithium salts.
7. *Bitter laxative waters:* Contain magnesium and sodium sulphates chiefly.

1. TABLE WATERS.—The class of mineral waters usually known as *table waters* are mild diuretics and stimulants to digestion and circulation, owing to their carbon dioxid, and can be given to patients as palatable beverages. Among these are the Poland Spring (Maine) and Great Bear Spring (New York) waters, that contain but a small amount of alkalies. A more alkaline water often used at table in this country is White Rock Spring water (Waukesha, Wisconsin), containing an appreciable amount of alkaline carbonates. The Apollinaris of Ahrweiller (Prussia), the Dorotheenquelle at Carlsbad (Bohemia), the Rosbach and Selters waters (Germany), the Malvern Springs water (England), Condillac (France) and Geyser Spa of California are other examples of simple carbonated waters.

2. ALKALINE CARBONATED WATERS (*Containing Carbon Dioxid and Sodium and Magnesium Bicarbonates as Chief Ingredients*).—These include Saratoga Vichy (New York), the French Celestine Vichy, the Salzbrunn water and the Neuenahr water (Germany). Celestine Vichy has in my practice proved to be the best general alkaline water that I have given.

These waters are indicated in inflammatory conditions of the urinary tract, especially of the bladder, in oxaluria, in gout and uric-acid diathesis and in calculous formation. They are diuretics, and antacids in the urine, rendering it alkaline. They also dissolve away mucus, allay inflammation in the bladder and act as solvents for uric-acid concretions. They diminish the excretion of oxalic acid.

3. ALKALINE-MURIATED WATERS.—The alkaline-muriated waters, which contain sodium chlorid in addition to carbonates, are also useful in chronic catarrhs of the bladder and renal pelvis. These include the waters of Selters and Ems, Saratoga Vichy (New York), Plymouth Rock Spring (Michigan), etc.

4. Earthy Waters.—Earthy waters containing large amounts of calcium and magnesium (carbonates and sulphate), with carbon dioxid and small amounts of iron. They are especially useful in chronic conditions associated with an abundant secretion of mucus, especially in chronic gonorrhea, in persistent cystitis, neuroses and hemorrhages of the bladder. They are contraindicated in the presence of calcium phosphate or carbonate calculi, in which simple carbonic-acid waters are best (Geyser Spa, Apollinaris, Selters). The earthy waters include a large number of springs here and abroad:

France: Contrexéville.

Bohemia: Marienbad.

Germany: Wildungen.

United States: Napa Soda Springs (California), Richfield Springs (New York), Mt. Clemens Spring (Michigan), Allouez and Waukesha Springs (Wisconsin), etc.

5. The Alkaline Saline Mineral Waters (*Sodium Sulphate Waters*).—These waters are of great value in gout, in lithemia, in urinary calculi, in obesity and in chronic nephritis, especially with albuminuria.

They usually contain CO_2 and besides sodium sulphate also sodium bicarbonate and chlorid. They should be taken *before* meals, never during or after meals, in amounts of from 6 to 40 ounces (Kisch). They are markedly diuretic, and in large amounts are purgative. They retard nitrogenous metabolism and increase the waste of fat. They are also solvent of uric acid. The following are the principal waters of this class:

Austria: Carlsbad, Marienbad, Franzensbad.

Switzerland: Tarasp.

Canada: Caledonia Springs (Ontario).

United States: Springdale Seltzer Springs, Boulder County, Colorado; Topeka Mineral Wells, Kansas, Geyser Spa (Hot), Sonoma County, California, Idaho Hot Springs, Clear Creek County, Colorado.

The Carlsbad Sprudel salt is sold in bottles in this country for the preparation of an artificial solution resembling the original water.

6. Lithia Waters.—These contain usually very small amounts of lithia and are used principally as uric-acid solvents. Whether they actually dissolve stones is not yet positively known. They are diuretic and useful in gout, and stone in the kidney due to accumulations of uric acid. They are usually taken in the morning, the dose being from 4 to 40 ounces (Kisch).

The chief foreign lithia springs are at Saltzbrunn, Homburg, Baden-Baden, Ems and Kissingen. A number of lithia springs exist in this country, including those in Arkansas (Lithia Springs), in Massachusetts (Ballardville), in New Hampshire (Londonderry Lithia), in New York (Saratoga) and in Virginia (Buffalo Lithia Spring).

7. Bitter Laxative Waters.—These contain chiefly sodium sulphate and magnesium sulphate, but also magnesium and calcium carbonate. Few of these contain carbon dioxid.

They are purgative waters and are taken in small doses (3 to 8 ounces) in the morning before breakfast. They are of great value in emptying the intestines before operations and in keeping the bowels clear in various conditions in which this is desirable, as in prostatics, etc. The principal bitter waters are:

Bohemia: Pullna.

Hungary: Alap, Hunyadi János, Franz Joseph, Apenta, Victoria.

Spain: Carabaña.

Germany: Friedrichshall.

United States: Crab Orchard Springs, Kentucky.

All my urological cases, while bed patients after an operation, are given either Apenta or Carabaña water every morning.

USE OF WATER IN UROLOGY

The Use of Water Introduced into the Passages of Excretion, Beneath the Skin and into the Blood Vessels

Rectal Irrigations.—Rectal irrigations with saline solution are employed in a variety of diseases of the urinary organs. They secure a thorough cleansing of the bowels; in shock, they supply heat; in uremia and other toxic conditions, they remove intestinal toxins and secure the absorption of a certain amount of salt solution into the blood. Locally, that is, applied to the lower part of the bowel, they relieve pain and discomfort in the prostate, the neck of the bladder, the vesicles and the posterior urethra. They allay spasm of the vesical sphincter and they counteract acute inflammation in the pelvic organs both in the male and female. The tube which I employ is called the recto-genital tube. It is a double-current tube with a curved end (Fig. 254). The inflow part of the tube is attached by a nozzle to the rubber tubing coming from the douche bag, and extends to the opening in its concavity. The outflow part begins in an opening on either side of the tube a little farther from the tip than the inflow aperture and ends in a nozzle at the distal end where it is attached to a piece of tubing carrying away the fluid into a basin or douche pan. The fluid flows into the bowel through the opening in the concavity and flows out through the side openings.

Fig. 254.—Recto-genital Tube.

Technique.—For douching the lower bowel, the patient lies in the bath tub in a reclining position (Fig. 255), or sits on a chair in a similar position (Fig.

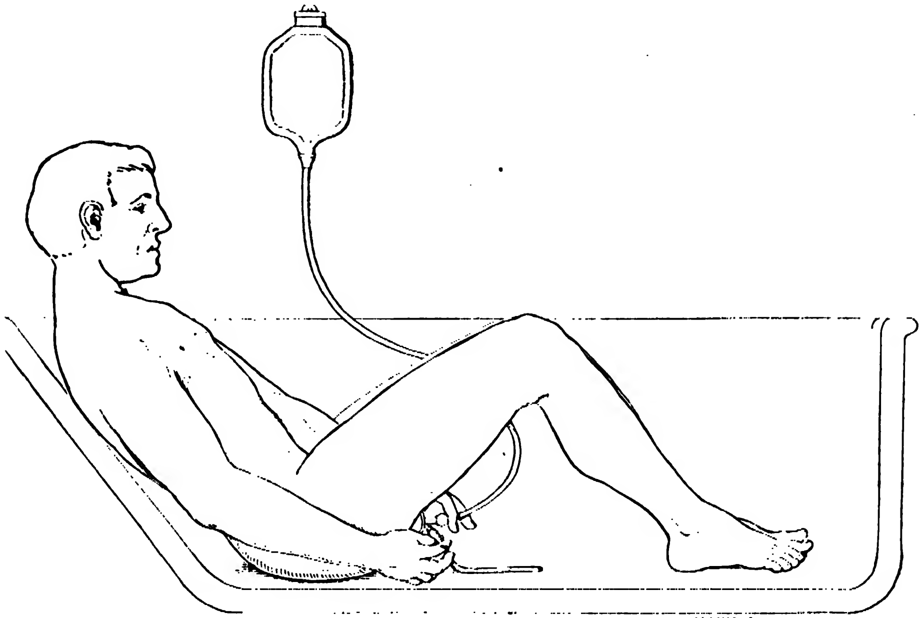


Fig. 255.—Rectal Irrigations. Patient in bath tub.

256). A gallon douche bag is suspended so that its bottom is just on a level with the top of the head, or two feet above the pubes. The douche bag is filled

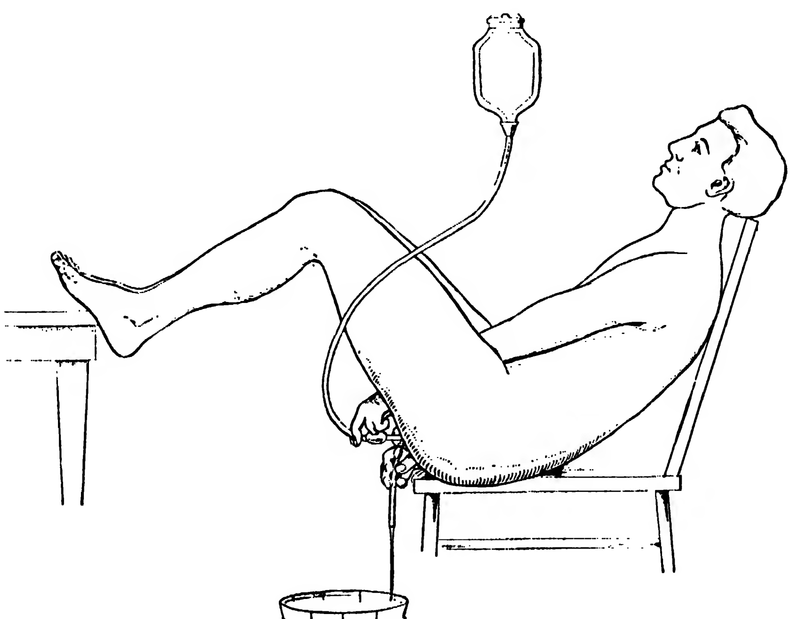


Fig. 256.—Rectal Irrigations. Patient reclining in chair.

with a gallon of salt solution containing a tablespoonful of salt to the gallon, the temperature of which, roughly speaking, is as high as can be borne by the hand, that is, about 105° to 130° F.

Before introducing the tube, its tip should be lubricated and the air should be expelled from it by allowing some of the solution to pass through. The tip of the left forefinger is then introduced just inside the front part of the anal orifice and serves as a guide to the tube, the tip of which is gently introduced into the rectum, at first with a slightly forward and rotary motion. When it has passed up for an inch and a half, it comes in contact with the apex of the prostate. The tip should then be tilted back toward the hollow of the sacrum and the tube should be pushed up for another inch and a half if the prostate is to be treated; or for three inches if the seminal vesicles are to be douched. When treating the vesicles, the tube should be tilted from side to side, so that its inflow opening lies over one or the other of the vesicles.

After the tube has been inserted, the solution is allowed to enter the rectum. Should the flow seem sluggish, or be arrested, the tube is probably blocked by fecal matter and it should be removed and thoroughly flushed out, when it can be reattached and reintroduced.

In case the sigmoid and colon are to be irrigated, the pelvis should be elevated and the patient should lie on the left hip. If then the outflow tubing be compressed, the solution will run up to the splenic flexure. Turning onto the right hip will then allow it to gravitate to the hepatic flexure and sitting up will allow some of the fluid to gravitate into the cecum. In urology, douches of the lower part of the large intestine are generally used and it is rare that one is called upon to wash out the entire colon.

Vaginal Irrigation.—This should always be given to the patient on her back with the hips elevated and a douche pan under the buttocks. The nozzle should always be of sufficient length to reach well behind the cervix of the uterus and the tip should be introduced along the posterior vaginal wall.

Although many eminent gynecologists maintain that vaginal irrigations are of no benefit in pelvic diseases, my experience has been quite to the contrary. I am now speaking of bladder troubles in women which are associated with affections of the internal genitals. There is a close relationship between the uterus and its adnexa and the bladder, and pressure upon this viscus as the result of inflammations or malposition of the female pelvic organs, gives rise to a variety of disturbances of the bladder functions. Hot vaginal douches of salt solution, prolonged and repeated daily, are very useful in the treatment of inflammatory conditions of the uterus and its appendages and have a good effect in relieving the bladder symptoms associated with these conditions. In treating cases of cystitis depending on or associated with gonorrheal and tuberculous affections, I have derived the greatest help from hot vaginal irrigations, especially when the internal female genitals were involved.

Irrigations of the bladder and the urethra in women are the same as in men, although the catheter is used in preference to hydrostatic pressure.

External Applications of Water

The urologist should be familiar with the effects of water at different temperatures, applied externally in the form of baths, douches, etc., as these measures form an important feature of treatment in urinary diseases. A very brief outline of the general principles of hydrotherapy will be given here.

Cold water when applied externally in the form of a tub shower or tub bath, is a vasomotor stimulant which produces contraction of the superficial, and reflexly of the deep blood vessels. Cold baths increase the blood pressure and stimulate the activity of all the organs of the body; but if too greatly prolonged the action is reversed; muscular activity is decreased and circulation is retarded. It is of value in treating patients suffering from genito-urinary conditions who need a general stimulation, as well as increasing the function of the pelvic organs.

Heat applied externally through the medium of baths, local or general, acts as a sedative, dilates the vessels and produces a hyperemia of the skin and consequent anemia of the vessels of the internal organs. Hot sitz baths, in this way, tend to lessen congestion of the pelvic organs. Hot baths also promote sweating and favor the radiation and abstraction of heat.

Baths.—Baths are divided into general and local.

General Baths.—General baths may be classified according to temperature as *cold*, from 50° to 75° F.; *tepid*, from 75° to 95° F.; and *hot*, from 105° to 115° F. The temperature of the bath room should be about 70° F.

The *hot* tub bath acts as a sedative and should be given for from five to twenty minutes, with the patient in a recumbent position. The best time to take these baths is before retiring and the bath should never be prolonged sufficiently to make the patient feel weak or dizzy.

The *cold* tub bath is a stimulant to metabolism and to excretory activity, as well as an excellent general hygienic measure. It should be taken in the morning and followed by a brisk rub. Its use is contraindicated in very weak patients. The cold tub bath may be used in septic conditions accompanied by a high fever, as it is employed in typhoid fever. The bath is begun at a temperature about 10° lower than that of the patient's body and the body is rubbed vigorously while the patient is in the water. The temperature is reduced to about 68° F. within fifteen minutes. The duration of the bath should be between twenty and thirty minutes. The head should be wrapped in a towel immersed in cool water before the patient is placed in the tub and after the bath the patient is to be thoroughly dried and placed in a warm bed.

Tepid baths are to be taken by those who do not react properly to cold baths and cannot stand the strong stimulation of the latter.

Sea Baths.—Sea bathing is one of the best adjuvants to other treatments in chronic urinary diseases of the urethral canal and in all cases in which we desire to promote the general health as well as stimulate the nervous system. They are especially indicated in neurasthenic patients, provided they are strong enough to bear them. Surf bathing, aside from its stimulant thermic influence, constitutes a general massage of the body. Swimming is one of the best exercises that can be indulged in. In order to insure the full benefit of a sea bath, a full reaction must be obtained and the bath should not be prolonged until the chilly sensations appear. It should be followed by a vigorous rub.

Salt baths made by adding sea salt (2 to 5 ounces to the gallon) to an ordinary tub of water are in a measure substitutes for sea baths and are stimulants to nervous and glandular activity. They are indicated in weak patients who cannot take sea baths.

LOCAL HYDROTHERAPEUTIC MEASURES.—Of the local measures, we must first mention the douche or shower. This may be a vertical rain douche, or a movable spray. The temperature used varies from the lowest to the highest employed in baths, while in the "Scotch douche" the temperature is alternately hot and cold. A cold shower is a powerful stimulant and is applied for about one minute, at from 50° to 60° F. Warm douches are used as sedatives in neurasthenia. The "Scotch" douche applied to the genitals is useful in sexual depression.

Sitz Baths.—Sitz baths may be either hot or cold. They are very useful in many urological conditions. They are taken in a special tub holding five to six gallons, or enough to reach the patient's navel as he sits in it. Ordinary washtubs may also be used. The *hot* sitz bath is sedative, antispasmodic and anodyne, and should be given for from ten to fifteen minutes twice a day as hot as can be borne. It is indicated in all acute inflammatory troubles of the pelvis, especially in the bladder, posterior urethra, prostate and vesicles. *Cold* sitz baths act as a stimulant to muscular contraction, if not too prolonged. They are employed in impotence, sexual debility, spermatorrhea, atonic conditions of the bladder and passive congestion of the pelvic organs. They should last for from two to five minutes only and are contraindicated in acute inflammatory conditions of the bladder, prostate, etc.

Wet Packs.—A method of reducing temperature and inducing profuse sweating is known as the "wet pack." A woolen blanket is placed upon the bed and over this is spread a linen sheet immersed in cool water and well wrung out. The patient is placed upon this sheet with his head wrapped in a towel wet with water at about 60° F., his arms are raised above his head and the sheet is tucked in all around his body; the woolen blanket is then carefully folded and tucked over the shoulders and entire body of the patient. A hot-water bag is then placed at the feet. The pack is left on until it becomes very

warm and a second pack, or several successive packs, can be applied until the temperature is reduced.

In urology the wet pack is indicated in febrile states, such as septicemia, and in cases of pelvic inflammations. In diseases of the kidneys, the hot pack is useful for promoting perspiration and elimination. They are contraindicated in patients with weak hearts.

Sponge Baths.—The cold sponge bath is used as an antipyretic measure in place of the cold tub bath, when less active treatment is sufficient, or when the condition of the patient is such that it is not advisable to move him about. When frequently repeated, it reduces temperatures to a considerable degree. The sponge bath should be followed by an alcohol rub, or some alcohol should be mixed in with the water.

Local Use of Cold Water and Ice.—Local inflammatory conditions are frequently treated by the external application of cold or ice water, either in coils or ice bag, while the combined part of the genito-urinary tract is treated by cold water indirectly applied by means of tubes called psychrophores.

There are two varieties of psychrophores, a urethral and a rectal. They are both hollow metallic tubes, closed at one end, with no outlet through which water can escape into the urinary or rectal passages. After the psychrophore has been introduced into the urethra or rectum, the nozzle is connected with the pipe from the douche bag and the cold water flows into the tube in a continuous stream, filling the tube, and escapes by an adjoining nozzle through a piece of tubing into a douche pan or basin. The metallic surface of the instrument is cooled and communicates the cold to the tissues with which it lies in contact. The psychrophore is used either in the rectum or urethra for passive hyperemia of the prostate and posterior urethra, especially in chronic inflammation of these organs associated with sexual debility, nocturnal emissions, spermatorrhea and prostatorrhea. Ice bags are used principally in cases of epididymitis complicating gonococcal urethritis.

Saline Infusion

Salt solution in the "physiological proportion," that is, 1 drachm to the pint, is introduced into the body in such a way as to combat shock, to supply loss of fluid due to hemorrhage, or to cleanse the blood from various poisons, as, for example, in uremia. The solution is introduced into the rectum or cellular tissues, from which it is taken up into the circulation; or else it is injected directly into the vein. The three methods of introducing saline solutions are called: (1) enteroclysis, (2) hypodermoclysis and (3) intravenous injection.

(1) **Enteroclysis.**—This is the simplest of all methods and should always be first resorted to in an emergency until the apparatus for the other methods can be prepared. It consists in the introduction of a soft-rubber rectal tube

of sufficient caliber high up into the bowel and the slow introduction of a salt solution, at 105° to 110° F., containing a teaspoonful of table salt to a pint of water. The fluid may be introduced through a funnel or with the aid of an ordinary douche bag and, in either case, the bottom of the reservoir should not be raised more than a foot above the pubes so as to avoid the forcible introduction which might be followed by reflex expulsion. The patient's pelvis should be elevated or he may be placed in the Trendelenburg position, unless it interferes with a surgical operation.

The saline enema is an excellent measure during or after operations to counteract hemorrhage and shock, and some surgeons employ it as a routine procedure in operating. One pint of this solution at a time is sufficient and, in case strong stimulation is required, two ounces of whisky can be added.

(2) **Hypodermoclysis.**—This consists in the introduction of the salt solution sterilized. It is recommended that a small amount of calcium chlorid and potassium chlorid be also added (making what is known as Ringer's Solution) into the cellular tissues through a hollow tube. The temperature of the solution should be 105° to 110° F. The apparatus needed is a sterile reservoir of any kind connected by rubber tubing to an aspirating needle. The patient is prepared as for a surgical operation, the skin being scrubbed and disinfected with alcohol and bichlorid. The apparatus is prepared and all the air is expelled from the needle before it is inserted. The place selected for the puncture should always be one where there is a great deal of loose subcutaneous tissue. In women, the space between the breast and the chest wall will be found convenient; in men, the fold of skin at the edge of the pectoral muscle at the border of the axilla.

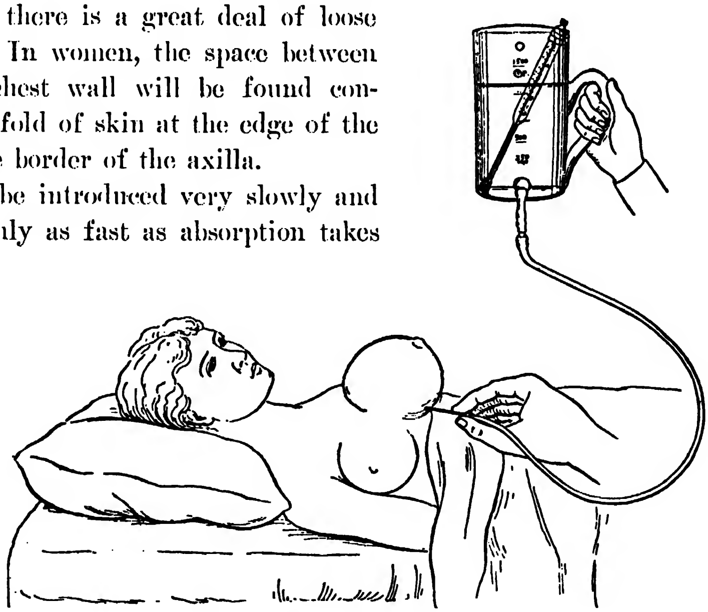


FIG. 257.—HYPODERMOCLYSIS. (From Ashton.)

The fluid should be introduced very slowly and should be supplied only as fast as absorption takes place. Not too much pressure should be used at any time and the vessel should be raised only enough to cause a constant flow. The amount of fluid introduced at one time varies. About six ounces can be introduced in an hour and from one to two quarts have been introduced within twelve hours (Fig. 257). Hypodermoclysis is especially useful in septic conditions, in uremia

and anuria, but, being slower than other methods, is less useful in hemorrhage and shock.

(3) **Intravenous Injection.**—In this method the sterile saline solution is introduced into a vein at the bend of the elbow through a special cannula. The

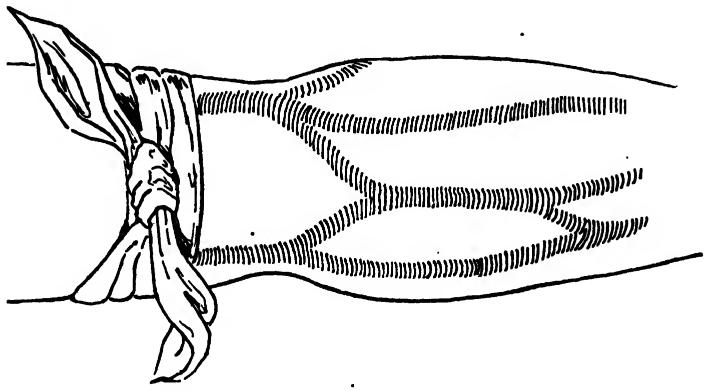


FIG. 258.—INTRAVENOUS INJECTION.
The arm is compressed above the elbow, thus making veins prominent

apparatus required is very similar to that for hypodermoclysis, excepting that it is advisable to have the jar graduated to determine better the amount of fluid entering the circulation. The rubber tubing and cannula must be sterilized by boiling, pinned in a sterile towel and allowed to remain there until needed.

The skin is prepared as for operation, a firm bandage is placed over the upper arm and tied on the side selected, thus impeding the venous flow and

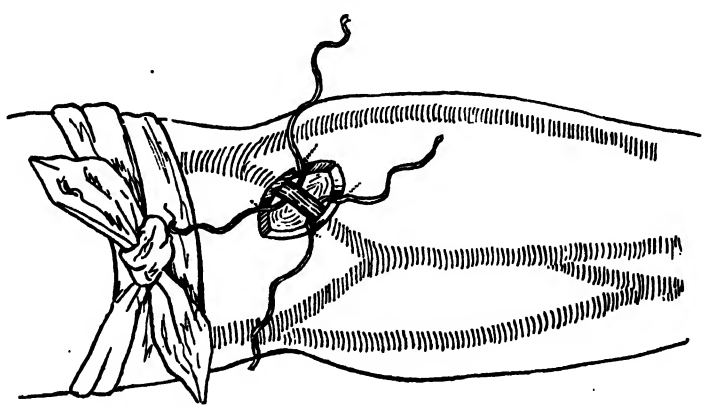


FIG. 259.—INTRAVENOUS INJECTION.
Shows the median basilic exposed and the ligatures passed beneath it

causing the veins of the forearm and bend of the elbow to bulge out (Fig. 258). The median basilic is the vein usually selected because of its large size. It is a branch of the median vein and passes obliquely inward across the bend of

the elbow joining with the common ulnar on the inner side of the elbow to form the basilic vein. The incision is made over its middle portion. The tissues over it are dissected away by blunt dissection and two ligatures are placed around the vein (Fig. 259). The distal ligature is tied, the proximal remains loose. A transverse incision is then made in the vein and the cannula is inserted into its lumen (Fig. 260, *A*, *B*), while the solution is running out of the tube, in order that no air shall enter the vein. The bandage is now loosened, allowing the solution to run into the vein, and if necessary the proximal ligature can be tied around the cannula so as to avoid leakage. From one to three pints is allowed to run into the vein. The elevation of the douche jar should be from three to six feet above the table. The flow should be at the rate of a pint in a half hour. The amount necessary to inject depends on the pulse of the individual, which should be carefully watched.

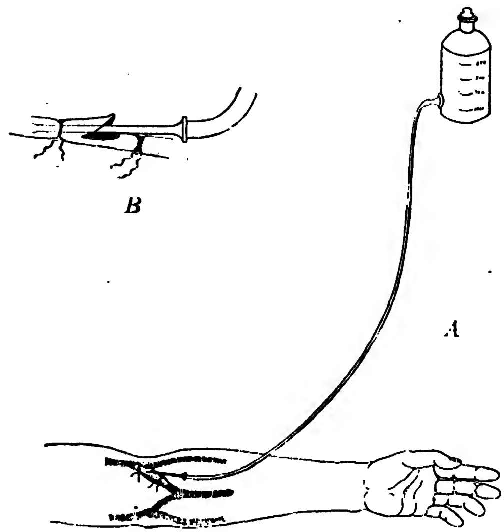


Fig. 260.—Intravenous Injection. *A* shows the cannula in the vein and the tube extending from it to the reservoir containing the solution. *B* shows the opening in the vein, the cannula inserted and the vein ligated above and below the opening.

After the injection is finished, the tube is withdrawn and the proximal ligature is tied. The temperature of the solution should be kept constantly at least 105° F. in the jar, so as to secure a temperature of over 98° F. as the fluid enters the vein. This may be accomplished by the addition of fresh hot solution. A sterile thermometer is kept in the jar for the purpose of regulating its contents.

CHAPTER XVII

ANESTHESIA IN UROLOGY

There are two varieties of anesthesia, general and local, the former of which will probably always be used in most of the major operations, while the latter will without doubt be employed more and more as the technique of its administration develops.

General Anesthesia.—The materials used in general anesthesia are liquids which are rapidly diffusible and therefore are readily transformed into gases that are inhaled and have a narcotic effect upon the patient. Of these, the ones generally employed are ether, chloroform and nitrous-oxid gas.

Ether is probably the best and safest in all major surgical operations. It is administered through inhalers which are usually about six inches in length, three inches in width, and five inches in height. Those that are sold as the most up-to-date appliances are made wholly or partially of metal with various mechanisms for holding gauze and cotton. They can also be constructed from paper folded in a strip five inches wide and fifteen inches long, this to be enveloped in a towel and then rolled up in oval form of the same dimensions already given. In this inhaler, ordinary absorbent cotton or gauze is placed and it is pinned together at the top, in this way forming a truncated cone. The inhaler is placed over the nose of the patient and the fluid is poured into the inhaler from above, or from below, either directly into the cone or through some apparatus leading to it.

Ether is also given by the drop method through a special or a chloroform inhaler, a process which takes a longer time, but which is considered safer for the patient, as he does not receive such a large dose suddenly.

Chloroform is administered by the drop method. The chloroform inhaler is spoon-shaped, made of a wire frame covered with gauze or flannel, and the liquid is dropped upon it very much as in the last method described for the administration of ether.

Of the two anesthetics, ether is safer on account of being a heart stimulant, although it is supposed to be contraindicated in diseases of the kidney, in which case, chloroform is considered advisable. The latter is, however, a cardiac depressant, and many deaths have occurred from its use. In a large operative service covering many years and many urological operations, I have never had a death that I could ascribe directly to ether.

Nitrous oxid is of value for examinations in urology and is also used for brief operations, although patients can and have been kept under its influence for an hour or more. The gas is contained in a cylinder in a compressed form, from which it escapes, on the turn of the valve, into a collapsed rubber balloon. When this is filled, the gas slowly passes through the inhaler and is breathed in by the patient. It is the safest of all anesthetics. It can be taken on a full or an empty stomach. No preparation for the anesthetic is required. There are no toxic symptoms following, such as vomiting and nausea. It may be considered harmless.

Dr. C. S. McNeille, the dentist at Cooper Union, who has had unusual experience with this variety of anesthesia, in speaking of its action as an anesthetic, says: "All statements in relation to this matter can only be approximate. In this office we have given it 259,000 times since 1863 with no deaths. Very few deaths in nitrous-oxid anesthesia have been reported, and those usually came from asphyxia. We have never had a death during an anesthesia. As to the advisability of administering the gas on a full or an empty stomach, I would say that, in my experience patients have never vomited during an anesthesia if the operator or his assistant held the chin well down on the chest of the patient and thus let the saliva run forward. I also find that the patients who come with an empty stomach are the only ones who have a headache after taking gas. Hence I am in the habit of advising them to take a light repast before the operation. As far as the time during which we can keep the patient under gas is concerned, I would say that I have kept a patient under gas for a surgeon for two and a half hours without intermission. The principal thing in keeping a patient under prolonged gas anesthesia is to watch the respiration and to give the gas so slowly as to prevent the system from being crowded with the vapor.

"As long as the rate of respiration is satisfactory, in fact as long as the patient is breathing, I do not care what the pulse may be doing. A man who knows how to give gas, will rarely produce the slightest degree of asphyxia. Should marked asphyxia occur, then artificial respiration must immediately be applied. As a rule, the patient recovers in from a half to two minutes, but it may be necessary to continue for a longer time. I believe that the stage of excitement in gas anesthesia is produced by a too rapid administration of the gas, and that in giving ether, this stage is the more severe and violent, the more we crowd the anesthetic in the first stage. The usual time for producing a narcosis for a tooth extraction is one minute. In administering gas, we are guided purely by the physiological effects and not by the pressure indicator on the reservoir."

The increasing popularity of nitrous-oxid gas as a general anesthetic has brought about its use as a forerunner to ether and chloroform in general anesthesia, so that now, especially in the administration of ether, gas is frequently given first, which renders the patient unconscious in a few seconds. Then the ether is continued by pouring it into a separate section of the inhaler made for

this purpose, and the patient passes from the influence of one anesthetic to that of the other quickly and with but slight disturbance. The method of combined anesthesia was introduced by Dr. Thomas Bennett, of New York, who became a specialist in this branch of work. By his well-devised apparatus and his skillful manipulation, he is able to give anesthesia, starting with nitrous-oxid gas, continuing with ether or chloroform and administering oxygen, if necessary, in such a way that the operator feels safe and his composure is never disturbed while operating. The result of Dr. Bennett's pioneer work in combined general anesthesia has been the development of anesthesia as a specialty, which has been taken up by a number of the younger men throughout the country.

The ease of operating under nitrous-oxid gas has been one of the chief incentives to find other easy methods of using anesthesia and especially to produce analgesia without rendering the patient unconscious, a condition which no one looks upon favorably and every patient dreads nearly as much as the operation. An analgesic condition can be brought about generally and locally by certain drugs. The best general analgesic is scopolamin, generally spoken of as the scopolamin-morphin injection; but drugs which render the body analgesic are rarely used, as they are considered dangerous to the life of the patient. Local analgesia or anesthesia is, therefore, preferable.

Spinal Anesthesia.—Spinal anesthesia has been used considerably in the surgery of the genital tract, especially in women. Personally, I have never used spinal anesthesia in urological operations, and, judging from what I have observed of its effect in the hands of other surgeons, I do not feel inclined to advocate its use, although Goodfellow, of San Francisco, and Boyd, of Panama, have found it most satisfactory in their work of prostatic surgery.

This method was introduced in 1885 by Corning, of New York, and worked out by Bier, Quincke and Sicard. It consists in the injection of a solution of cocain (or another anesthetic) into the subdural space in the spinal canal. The effect of this is to render the entire lower part of the body anesthetic through the action of the drug upon the spinal nerve roots in the cauda equina.

The puncture is made with a long strong hypodermic needle beneath the second lumbar vertebra (in children, the third) a little to one side of the median line. The patient lies on his side with legs drawn up. The skin is disinfected as for an operation; then it is anesthetized with a 0.1-per-cent solution of cocain, or with the ethyl-chlorid spray. The needle, syringe and solution are sterilized. The dose of cocain is 0.01 to 0.02 gram in a syringeful of physiological salt solution with one drop of adrenalin. The needle is first introduced and a sufficient amount of spinal fluid allowed to escape. The syringe is then attached and the solution is slowly injected. The needle is withdrawn and the puncture closed with plaster. Anesthesia occurs in ten minutes.

Local Anesthesia.—Local anesthesia occupies a very important position in urology, as it renders the examination and treatment painless in many cases,

and operations can be performed without pain, or with a minimum amount of suffering.

The methods of applying local anesthesia are by freezing; by application to the mucous membrane or skin; by intra- or hypodermic injections or infiltrations; and by injections into the urethra, bladder and tunica vaginalis.

Freezing Methods.—Freezing methods have been popular since the introduction of the ether spray by Richardson in 1866. In the following year, Rothenstein introduced the ethyl-chlorid spray, which supplanted it and has been extensively used in minor surgery.

Ethyl chlorid is a colorless liquid which is sold in glass tubes provided with a stopcock. When grasped in the hand and the valve is opened, the warmth of the hand suffices to vaporize the fluid. The tube is held at a distance of ten to fifteen inches (25 to 40 c.m.) from the spot to be operated, the fine spray striking the surface, giving it a frosty appearance when it is frozen and anesthetized.

A number of other freezing substances have been introduced since ethyl chlorid, but this is as effective as any of the newer preparations. The spray must be interrupted when freezing takes place, as permanent damage to the tissues may be brought about by prolonged freezing. Personally, I rarely use the freezing method, as it is not as practical, nor as far-reaching as other local anesthetics.

The Application or Injection of Anesthetic Solutions.—Cocain.—Of the large number of anesthetic drugs now known, the preferable one in routine work is cocain. Cocain is an alkaloid from the leaves of the coca plant. The salt used in local anesthesia is cocain hydrochlorate and is spoken of in this chapter as cocain. It is a white crystalline powder, soluble in water and alcohol. It has an anesthetizing power when placed upon mucous or serous membranes or when injected into the tissues, which was first discovered by Koller, of New York, who utilized it in anesthetizing the eye in his operations on that organ. It paralyzes the nerve terminals of the sensory nerves in the skin, the subcutaneous and other tissues, and also paralyzes, in a less marked degree, the motor peripheral nerves.

Dosage of Cocain.—The dose of cocain internally is 1 grain (or 6 cgm.); injected intradermically, or into the deeper tissues, the dose is from 1 to 2 grains (or 6 to 12 cgm.); while, on the skin or mucous membrane or the external genitals, 6 grains (or 36 cgm.) or more can be used.

The dose according to the strength of the solution is as follows: Of a 10-per-cent solution, drops 10 are used; of a 4-per-cent solution, drops 25; of a 2-per-cent solution, drops 50; and of a 1-per-cent solution, drops 100.

The quantity generally used in this country for urethral and bladder injections is ½ ounce of a 1-per-cent solution. Chismore, of San Francisco, used in his office practice for several years a 3-per-cent solution, of which he was in the

habit of injecting 3 ounces into the bladders of his patients as a matter of routine in crushing vesical calculi.

Method of Administration.—In the hospital, for intradermic injections, we use Bodine's tubes put up by Squibb, each tube containing 1 grain of sterilized cocain and a certain amount of salt. The solution is made by breaking the tube and adding its contents to 1 ounce of sterile water. The proportion of salt in the tube is sufficient to make a solution corresponding to 1 grain of cocain in 1 ounce of normal salt solution. We can, therefore, see that:

Tube 1 (gr. 1), added to water 1 ounce, makes a 1 : 500 or $\frac{1}{5}$ of 1-per-cent solution; the strength and dose for intradermic injections.

Tube 1 (gr. 1), added to water 2 ounces, equals a 1 : 1,000 or $\frac{1}{10}$ of 1-per-cent solution; to be used for injections into the deeper tissues.

For urethra and bladder solutions $\frac{1}{2}$ of 1-per-cent strength is used. It, therefore, follows that:

Tubes 5 in number (grs. 5), added to 2 ounces of water, makes a 1 : 200 or $\frac{1}{2}$-per-cent solution.

Generally, however, the tablets of cocain are used for preparing these solutions, especially in all exploratory and cystoscopic work. Five $\frac{1}{2}$-grain cocain tablets to 1 ounce of water, would make a 1 : 200 solution, or $\frac{1}{2}$ per cent. Powders of similar strength can be used in place of tubes or tablets in making these solutions.

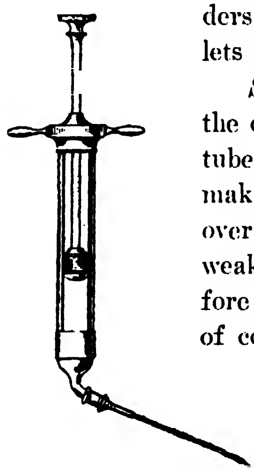


FIG. 261.—SYRINGE FOR LOCAL ANESTHESIA. Needle bent at right angles.

Sterilization of Cocain Solutions.—In the Squibb's tubes, the contents are sterile, and it is simply necessary to break the tube, letting the powder fall into the sterile water. After making solutions from tablets or powder, they should be held over a flame and brought to a boil once, as prolonged boiling weakens the solution. The solution should be freshly made before operating, as cocain solutions spoil quickly. Each powder of cocain can contain incorporated in it the proportion of salt sufficient to make a solution, corresponding to 1 grain of cocain in an ounce of normal salt solution for a $\frac{1}{5}$-of-1-per-cent solution, or by adding 5 grains to 2 ounces of water a 1 : 200 solution will be obtained.

The syringe used for intradermic and deeper injections is one holding either 5 c.c. or 10 c.c. of the solution. The barrel and piston are both made of glass. Both the syringe and needles are sterilized by boiling. The syringe with a finger brace is preferable. The needle and syringe should have a simple socket joint. For infiltration work, needles bent at right angles to the barrels are useful (Fig. 261).

Technique of Injection: Intradermic and Subdermic.—The syringe should be held with the thumb on the piston, and the first and second fingers should be

on the cross piece of the barrel. (See Fig. 262.) Care should be taken that the pressure is used only in the axis of the instrument with a free wrist, so as not to break the needle.

A method at our disposal for incising or excising diseased, inflamed or suppurating tissues is, first, to isolate this area by surrounding it with an anes-

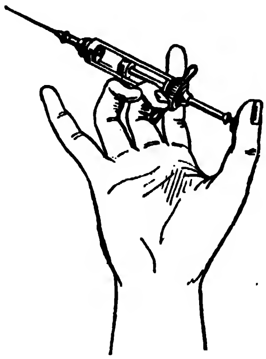


FIG. 262.—METHOD OF HOLDING THE SYRINGE.

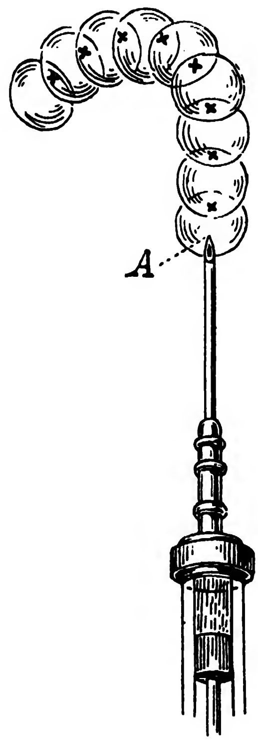


FIG. 263.—METHOD OF MAKING THE BLEBS IN INTRADERMIC INJECTIONS. *A* shows the puncture of the first bleb. The crosses (x) show the introduction of the needle for the succeeding blebs. Only the first puncture is felt.

thetized region carefully mapped out; second, to anesthetize a strip of skin and then gradually work deeper, to render anesthetic all the tissues to be included in the field of operation.

The first principle to be observed is that the needle should not be pushed forward or reintroduced, save through an already anesthetized field.

The skin and subcutaneous tissue is best anesthetized by the following method (Fig. 263). The needle is pushed *into* the skin (not subcutaneously) just far enough to cover the beveled point. Then a little pressure is applied to the piston and a small white wheal or bleb is raised which renders the skin anesthetic. The needle is withdrawn and the point is now reintroduced at the distal margin of the bleb where a new bleb adjacent to the first is made, continuing in this way until a strip of anesthetized skin is obtained for an incision.

If a larger area of skin is to be anesthetized, we can use a modification of Reclus and Schleich's infiltration methods on the ground that, if the subcutaneous tissue under an area of skin be anesthetized, the surface will also become anesthetic after a few minutes. Two points at opposite sides of the area are marked on the skin by raising blebs (Fig. 264). From these points, a

long needle is introduced in a radiating direction into the subcutaneous tissue, injecting cocain always ahead of the needle and following with the point. The diagram shows how the area is covered subcutaneously. After a few minutes, the entire skin surface over this area is anesthetized, which is especially applicable in excising ulcerated or diseased lesions of the skin, and in obtaining skin grafts. Other forms, as the oval or the diamond, can be injected in a similar way, depending on the shape and location of the area to be operated.

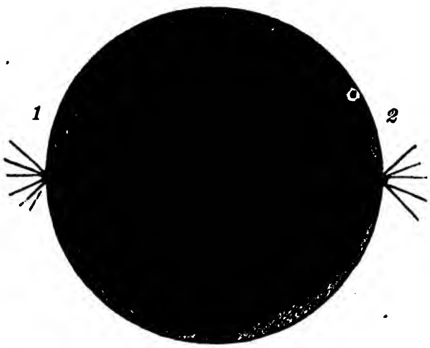


Fig. 264.—The Subcutaneous Method of Anesthetizing an Area to be Operated Upon. Numbers 1 and 2 show the points at which the needles are introduced in radiating lines.

When it is desired to cocainize a section of skin and a mass of tissue beneath it, the oval or diamond may first be marked out by four blebs. Then the cocain is injected deeply into the tissues to the depth to which it is thought that the operation will extend, and while proceeding with the operation, an injection can be made from time to time into the deeper tissues to be invaded. It is well to remember that 1 : 500 solution is used intradermically and 1 : 1,000 subdermically.

The operations that are performed under cocain are usually those of a minor type, although many of a major nature are equally successful. It is principally indicated in circumcision, meatotomy, internal urethrotomy, external urethrotomy, vesical lithotomy and operation on any suppurative condition from the external urinary meatus to the mouths of the ureters.

In kidney work, with the exception of cases of perinephritic abscess, a general anesthetic should be used. It is very difficult to keep the parts sufficiently relaxed under cocain anesthesia to deliver a kidney, unless it is very small or freely movable. I will take up the technique of local cocain anesthesia more in detail under the operations in which it is used.

Cocain Poisoning.—Cocain poisoning is usually manifested suddenly by an attack of vertigo. Often there is a partial or actual collapse, irregular, weak or fluttering pulse, and cold perspiration on the surface of the body. The attack may be followed or accompanied by vomiting; sometimes syncope occurs and may last for a few minutes.

In a certain class of cases, there is a feeling of excitation, the result of irritation by the drug of the brain cortex. It resembles somewhat the period of excitement of chloroform anesthesia, excepting that consciousness is not so deeply affected. The patient becomes excited, noisy, laughing and chattering in incoherent delirium. There is frequently dryness of the throat, a heavy feeling over the heart and disturbances of sensation, as a tingling or numbness

of the limbs, or the loss of sense of sight or hearing. The pupils may become widely dilated and insensible to light. Sometimes there is twitching of the muscles, or loss of reflexes, while in fatal cases there is usually coma and death due to paralysis of the respiratory system.

Preventive and Palliative Treatment of Cocain Poisoning.—We should always be on our guard against poisoning, as cases have been reported in which slightly over one grain used hypodermically or injected into the serous and mucous cavities has proved fatal. The following precautions are recommended by Reclus:

The patient should lie horizontally while being cocainized and should remain in this position from twenty minutes to three hours, according to the gravity of the case. Before the injections are made, the part should be compressed by a band above the locality to be anesthetized, and this compression should continue for a half hour after the operation.

If symptoms of cocain poisoning come on at any time, the patient should be made to lie flat; the heart should be stimulated by injections of strychnin, digitalis or atropin, one or all, according to the pulse; besides which, friction of the body and the extremities should be resorted to. Artificial respiration may be needed if breathing threatens to stop. Drops of amyl nitrate should be immediately used if at hand. In case the trouble is due to a solution in the bladder, the viscus should be emptied and washed with saline solution. If there are convulsions, ether inhalations are indicated.

In conclusion, I will say that in all uncomplicated cases of urethral surgery and in cases of vesical calculus, cocain can be used; but it is important to have an assistant to give the injections and infiltrations, who is accustomed to the technique of the administration. For prostatectomies, extirpation of vesical tumors, nephrotomies and nephrectomies, it is important to have a special anesthetist of the highest possible grade if the operator desires to feel at ease during the operation, as in that latter group of cases in my practice, the hemorrhages are often alarming.

CHAPTER XVIII

DISEASES OF METABOLISM

URICACIDEMIA

Uricacidemia is the condition in which an excess of uric acid in the blood is characterized by various nervous symptoms and frequently by the local phenomena known as gout.

This does not mean that an excess of uric acid in the urine as shown by its analysis indicates the uric-acid diathesis or gout, as is supposed by many. These conditions are the result of uric acid retained in the blood and tissues, and not of that eliminated with the urine. It may be said, and at times it is no doubt true, that the amount of uric acid and urates contained in the urine is in proportion to that retained in the body.

The formation of uric acid in the body and its rôle in disease are still subjects of discussion. Formerly it was thought that uric acid was a product of nitrogenous changes, an intermediate between the foodstuffs and the final product of urea. It is thought at present that uric acid is formed by oxidation of nucleic acid and that foods rich in nuclei, such as meats, give rise to its formation and elimination in large quantities. It is impossible to know, however, whether or not uric acid is also derived from some other constituent of the food. Excessive accumulation of uric acid in the blood and tissues is more frequently the result of imperfect elimination than of increased formation. Uric acid is a very insoluble substance and a slight decrease in the alkalinity of the blood may cause its retention and accumulation in the tissues. We hold at present that uric acid is not formed in the kidney, but in the tissues, in the liver and in the spleen.

The normal amount of uric acid in the urine is from 0.4 to 0.52 grams (6 to 8 grains) in twenty-four hours.

The proportion of uric acid to urea is as 1 to 45.

A deposit of uric acid and urates in the urine does not necessarily indicate an excess of uric acid. Such a deposit may occur on cooling, as the result of acid fermentation. Urines of high acidity may deposit uric acid, irrespective of the absolute quantity of the latter in the specimen. Whether uric acid is really increased or not, we can only know by quantitative analysis.

Uric acid is *increased* in the urine by an abundant meat diet, containing

much nuclear substance and by a sedentary life, often the use of tea and coffee, certain drugs, as the salicylates and also in the following diseases:

1. In acute fevers and in most acute diseases.

2. After an attack of rheumatism and gout, when normal elimination has been reëstablished.

3. In diseases of the lungs and heart accompanied by diminished oxidation (pneumonia, hydrothorax, chronic heart diseases).

4. In large abdominal tumors, ascites, respiratory insufficiency.

5. In diseases of the liver and spleen.

6. In pernicious anemia and leukemia, due to the destruction of the nuclei of the leucocytes.

7. In diabetes mellitus.

Uric acid is *diminished* in the urine by a vegetable diet; after a diet of milk, eggs and dairy products; after eating cherries and similar fruits.

It is also diminished in chronic diseases of the kidney and in other conditions, with a decrease in the amount of urea; in gout, during acute attacks and in chronic wasting diseases.

Symptoms.—Uricacidemia is clinically characterized by a certain group of symptoms, sometimes spoken of as the gouty state.

Heredity plays an important part, and in many families various manifestations may be of frequent occurrence.

In addition to attacks of gout proper, a tendency to uric-acid diathesis may be responsible for more or less frequent attacks of headaches, neuralgias, sciatica, biliousness, affections of the skin, such as eczema, etc.

Later in life, after the prevalence for many years of uricacidemia, the more serious results of the disorder become evident. Arteriosclerosis frequently develops, leading to a fatal termination by nephritis, apoplexy, or aneurysm.

The presence in the urine of an excessive amount of uric acid in crystalline form often acts as an irritant to the genito-urinary tract and always renders the patient liable to renal or vesical calculus.

Treatment.—In the treatment of uricacidemia, the fact that gluttony and errors in diet are the most frequent etiologic factors must be constantly kept in mind. The daily amount of meat and fat-producing foods must be reduced, and a vegetable diet substituted. Alcohol must be interdicted altogether. Elimination should be favored by the free use of mineral waters, such as Apollinaris, Vichy, Selters, as well as by gymnastics and outdoor exercise.

The long list of useful therapeutic agents includes the lithium salts, colchicum, uricidin, piperazin, the salicylates, etc.

URIC-ACID DIET

Avoid.—Bisque, cream and tomato soup; corned, dried, smoked, canned, preserved or fried meats or fish. Tongue, ham, veal, pork, turkey, beef, lob-

sters and crabs. Highly spiced sauces and peppers. Hot rolls, cakes of all kinds; all cereals, as oatmeal, hominy, etc.; sirups, sweets of all kinds; everything made from corn; potatoes, or vegetables rich in sugar, as beets. (Just sufficient sugar to sweeten coffee can be used.) Strawberries, bananas and melons.

Spirits—brandy, whisky, gin and rum; good whisky is the least injurious, taken with meals and well diluted with water. One or two Scotch whiskies a day, well diluted, can be taken with meals or after them, if the patient is below par; or a glass of claret with the meal. Heavy wines, also champagne, Burgundy, beers and ales.

MAY EAT.—Oysters and clams, *consommé* and thin soups (without tomato), fish, beef, lamb and chicken, roasted, boiled or broiled, never fried. Salads of lettuce, romaine and chicory, with French dressing, consisting of four parts of oil to one of Tarragon vinegar, salt and white pepper. Dry toast and light, unsweetened, dry bread. Green string beans and peas; spinach occasionally; cauliflower and Brussels sprouts, if they can be digested. Apple at lunch and grape fruit for breakfast, without sugar, are the least harmful, although no fruits are necessary. Lemon is the least harmful.

N. B.—No tea. Coffee with hot milk for breakfast.

Water Diet.—One glass of water on arising; one glass at lunch; one glass at dinner; one between meals; one on retiring. Small cup of mild, black coffee may be taken after lunch or dinner.

DIETARIES.—The following is the dietary which Sir H. Thompson recommends in calculous affections:

"Fish in all forms, except those containing much fatty matter—i. e., herrings, mackerel, eels and the thin part of salmon. Game in all forms. Poultry. Lean meat in moderate quantity. Preparations of gelatin, savory jelly, or jelly agreeably flavored, but unsweetened. Butter in moderation (this is the only direct form of fat admitted, fat in some form being necessary). An egg or two on account of their usefulness in all cooking operations. (The objection to eggs applies only to the yolks.) Milk in strict moderation, and only with tea, coffee or cocoa. It is very undesirable and noxious in large quantity, as it contains a large proportion of fat and sugar, and its casein is digested with difficulty. It is less objectionable when thoroughly skimmed. Well-made whole-meal bread. Oatmeal. Pearl barley. Macaroni and other Italian pastes. Some coarse meal is needed to act as an aperient and prevent constipation. Whole-meal bread is improved in flavor and texture by an admixture of fine (not coarse) Scotch oatmeal, in the proportion of about one quarter to one third of the wheat meal employed.

"Dry haricots and lentils are most nutritive vegetables, and should be taken made into *purées*. They are digested with ease and contain much nutritious matter. Rice, sago, tapioca and arrowroot are all useful if treated as

savory dishes, and not as sweets. Fresh green vegetables are especially good. Fresh green peas and broad beans, well masticated. Light salads are permissible to persons who digest them easily, but they must not be taken by those who digest them with difficulty. Celery, sea kale, asparagus, tomatoes, potatoes and artichokes are all permitted; so also are apples, roasted or baked, without added sugar.

"The following are to be avoided: Rhubarb, gooseberries, currants, strawberries, raspberries, grapes, plums, pears and all sweet fruit, fresh or preserved. Saccharin may be substituted for sugar."

INDICANURIA

The urine often contains substances, not necessarily indicative of very great departures from health, but rather to be considered as danger signals, not to be ignored altogether. Thus, it may contain those known as chromogens, that is to say, bodies which do not of themselves color the urine, but subsequently develop a characteristic color under special conditions, either on standing or on the addition of agents that cause oxidation.

Indican may be defined as the chromogen of indigo blue. It arises from the absorption on the part of the intestinal canal of the parent substance, indol, which itself results from the decomposition of proteids.

In the human intestine in health, indol is formed in small amounts. It is one of the products of the bacterial putrefaction of albuminous compounds, and is physiologically increased on a diet rich in meats or animal food, containing a large proportion of proteid. The indol thus absorbed by the intestine becomes in the tissues through oxidation a new substance, indoxyl, which is excreted in the urine, as a rule in conjugation with sulphuric acid—as indoxyl-sodium or potassium sulphate—and also it is found in small proportion as indoxyl-glycuronic acid.

Pathological Indicanuria.—The clinical importance of the presence of a large proportion of indican in the urine has been exaggerated by some, but is more apt to be underrated. Its significance in the light of recent researches can scarcely be doubted. It affords valuable evidence of excessive proteid decomposition in the presence of bacteria; these are the agents of processes of putrefaction that lead to disturbances in the liver, to the various forms of gastritis, to constipation and diarrhea and those processes of putrefaction and fermentation gathered loosely into the general idea of "toxemia and autointoxication."

Experience shows that an increased output of indican is observed in cases of intestinal obstruction, associated with atony and with a deficiency of acid in the gastric juice, and in not a few intestinal disorders dependent on a diminished flow of bile. According to Simon, the deficiency of hydrochloric acid in the stomach is intimately associated with the development of indican. Thus, indicanuria occurs frequently in carcinoma of the stomach, in subacute and

chronic gastritis and in those forms of dyspepsia where the motor power of the stomach is impaired. It is also present in typhoid fever.

Examples of excessive albuminous putrefaction and of the bacterial activity leading to the formation of large amounts of indican in conditions to be met with elsewhere than in the alimentary tract, are afforded by cases of putrid empyema, fetid bronchitis and pulmonary gangrene, the importance of which has been fully set forth by Von Jaksch.

Symptoms.—The symptoms of indicanuria are various, and are in many cases difficult to trace to their true relation with the output of indol.

In general, it may be said that indicanuria is commonly associated with gastro-intestinal disorders marked by flatulence—the sign of bacterial growth—and of the nondigestion of fats, prominently disclosed by alternating attacks of constipation and diarrhea. A long train of symptoms, nervous, hepatic and renal, take their origin in putrefying processes in the intestine, which at the same time give rise to the presence in the urine of indigo-yielding substances. It becomes necessary, therefore, to examine the urine for indican whenever the signs of gall-stone disease appear, whenever there is pain or colic, or jaundice; and though the mere presence of indican should not be regarded as pathogenic, it gives a clew to the nature of the disease and its treatment. Thus, a furred tongue, injected eye, loss of appetite, headache, torpor, both mental and bodily, tenderness over the liver and abdomen, may occur without indicanuria, but they may just as well coexist with it, and such signs should lead us to examine the urine.

Treatment.—The treatment of indicanuria consists of those remedies which are intestinal antiseptics and those which stimulate bile secretion. No single drug should be used continuously, more benefit being derived by using different members of these groups from time to time.

Salol is the most frequently used and is given in doses of from 3 to 5 grains three times a day after meals, either in tablets or capsules.

Beta-naphthol and naphthalene come next in efficiency and are given in doses of 2 to 5 grains in capsules three times a day, after meals. Sodium iodid is useful in cases in which there are accompanying nervous symptoms, 10 to 15 grains in solution being given three times a day after meals. Sodium benzoate is also valuable as a remedy and is given in doses of 10 to 20 grains in capsules or solution after meals. In cases of hyperacidity due to intestinal fermentation, sodium bicarbonate is of value, 10 to 30 grains being given in solution or capsule after each meal. Of the remedies used when fermentation or putrefaction is due to an insufficient flow of bile, the glycholate and taurocholate of sodium are useful. They may be given in capsules, 3 to 4 grains in a capsule, after meals, or every three to four hours during the day. Phenolphthalein has of late been used when indicanuria is associated with constipation, as it acts as a cholagogue and laxative. It is given in capsules or tablets, in doses of from 5 to 30 grains, before retiring.

OXALURIA

Oxaluria means the presence of an excessive amount of oxalate of calcium in the urine. When found occasionally in moderate quantity, these crystals are of no clinical significance, as they may appear under normal conditions after eating fruits and vegetables containing comparatively large amounts of oxalic acid, such as rhubarb, tomatoes, spinach, cabbage, turnips and sorrel.

Oxalic acid is a product that is formed as an intermediate step in the combustion process, and comes between urea and uric acid in the series. It is found in very small quantities in normal urine in the form of calcium oxalate, but it is contained in normal specimens occasionally only, after the urine has been left standing for a time.

Urine containing numerous crystals of calcium oxalate for any length of time is not the urine of a healthy individual, and the condition is one that should be treated.

Oxaluria is merely a symptom pointing to a debilitated condition of the system. Of the cause of this condition, little is known. Generally, oxaluria is associated with conditions of nervous debility, perhaps especially often with those arising from sexual excesses. This is so frequently the case, that one should always be on the lookout for spermatozoa, if, in examining the urine of a nervous individual, calcium oxalate is found.

Oxaluria may also give rise to local irritation in the genito-urinary tract. When the crystals are formed in the kidney as they very frequently are, their passage through the kidney tubules, pelvis and ureters may give rise to lumbar pains or hematuria, or the crystals may collect around epithelial cells and mucus and form into concretions in the kidney or renal pelvis, causing renal colic, or they may irritate the bladder and urethra, bringing on frequency of urination.

The urine in cases of pronounced oxaluria is of high specific gravity, often reaching 1.040. Even when there are no subjective symptoms of irritation, the microscopic examination usually shows the presence of red blood corpuscles, mucus and epithelia.

Treatment.—Regulation of the diet, and exercise, are of the greatest importance.

The diet indicated should be one that limits the amounts of all articles containing large amounts of oxalic acid. Water, weak coffee and tea are the most suitable drinks. Alcoholic beverages are not especially forbidden, but should be taken in moderation.

In order to dilute the urine, the patient should drink water freely. The carbonated alkaline waters, such as Apollinaris, are especially useful. Many authors, as Klemperer, Tritchler and others favor the bitter waters containing magnesia, such as Friedrichshall, Hunyadi, etc.

Some cases are greatly benefited by the administration of nitromuriatic acid.

DIET IN OXALURIA

From the following list of foods, a diet suitable for patients having oxaluria may be selected:—

Foods Permitted.—*Clams* and *oysters, consommé* and thin soups without tomatoes, all kinds of *meat* and *fish* (baked, boiled or broiled), stale bread and toast. *Vegetables:* Fresh string and lima beans, green peas, lettuce, chicory and romaine salads; later on, Brussels sprouts and cauliflower may be added. *Fruits:* Apples are for lunch, peaches or grape fruit without sugar are the least harmful for breakfast in moderation. *Cereals:* Oatmeal, well cooked, may be taken in small quantities.

Foods Forbidden.—All vegetables not mentioned in foregoing list; especially injurious are potatoes, tomatoes, spinach, rhubarb, beets, turnips, dried beans. *Fruits:* Strawberries, plums, figs. All sweets are interdicted. *Meats:* All glands such as pancreas, thymus, liver and kidneys, on account of the many nucleins contained therein.

EXTRA DIET IN OXALURIA

A More Rigid Diet Covering a Longer Period

First Week.—As purely nitrogenous as possible, may take milk, meat (boiled, broiled or roasted), fish, eggs once a day. Nothing fried, pickled, salted or canned, or preserved in any way. Should drink *pure water*, at least three quarts a day. Nothing to be taken except those things mentioned.

Second Week.—To above may be added cucumbers, celery, lettuce and asparagus.

Third Week.—To above may be added raw oysters, oyster broth, *green peas, string beans,* any broth or variety of clear soup.

Fourth Week.—Grape fruit, lemons and cauliflower may be added, pears, peaches, baked apples, grapes in moderation, melons, well-cooked oatmeal in small amount and well-toasted or stale wheat bread.

Interdicted.—Potatoes, spinach, rhubarb, beets, turnips, dried beans, tomatoes, strawberries, plums, figs, or sweets added to the above.

DIABETES AND GLYCOSURIA

General Consideration

Diabetes and glycosuria are discussed together in this chapter because they are so frequently confused with one another, owing to the fact that, in diabetes mellitus, glycosuria is present.

Diabetes.—Diabetes is a disorder of the body metabolism, characterized by the passing of excessive quantities of urine. There are two forms of diabetes: Diabetes mellitus and diabetes insipidus.

Diabetes mellitus is the most important form. In addition to the polyuria and the intense thirst which characterizes both forms of diabetes, we have here the presence of sugar in the urine. When diabetes is spoken of without qualification, this form is usually referred to.

Diabetes insipidus is a name applied to that form of diabetes which is characterized by the passage of abnormally large quantities of normal urine of low specific gravity, and by intense thirst.

Glycosuria.—Glycosuria means the presence of sugar in the urine, from any cause, in excess of 0.1 per cent.

There are three varieties of glycosuria: (1) The alimentary, (2) the toxic, (3) the diabetic.

Alimentary glycosuria occurs in healthy individuals in certain disturbed conditions of digestion and elimination; also in diseases of the liver and of the brain, especially when the latter affects the fourth ventricle; in goiter and after injuries. Alimentary glycosuria may occur after the ingestion of large amounts of starch.

Toxic glycosuria occurs in fevers, after drinking large amounts of alcohol and after poisoning with lead, phosphorus, morphin, atropin, chloral, amyl nitrite, acetone, carbon dioxid, curare and strychnin.

Phloridzin glycosuria should be classed under toxic glycosuria. Although phloridzin is a glucosid, the amount of sugar passed after its administration is too great to be accounted for by that derivable from the drug. Phloretin, which is a derivative from phloridzin, is free from sugar and produces the same result.

Diabetic glycosuria constitutes the disease known as diabetes mellitus.

Diabetes Mellitus

Pathology and Etiology.—The pathology and etiology of diabetes, like those of other disorders of metabolism, has not been definitely determined. The glycogenic function of the liver is deranged, and an excess of sugar passes into the blood and is eliminated with the urine. The bulk of the sugar thus passed is derived from the carbohydrates in the food; in severe cases, a certain amount of the sugar seems to be the result of metabolism of the proteid constituents of protoplasm.

The amount of sugar eliminated in diabetes varies considerably. It ranges from a mere trace up to ten per cent and even twenty per cent; average two to three per cent. The percentage of sugar in the urine is by no means an accurate index of the severity of the pathological process.

The total amount of urine passed also varies greatly. In mild cases, the

daily quantity may not exceed six to eight pints; in severe cases, thirty to forty pints are often passed.

The specific gravity is high, varying according to the saccharine contents of the urine from 1.025 to 1.060.

Diabetic urine has a sweetish taste and aromatic odor, increasing or diminishing with the amount of sugar.

Symptoms.—The great prominent general symptom of the disease is intense thirst, a large quantity of water being required to keep the sugar in solution. There is also usually a great craving for food; in spite of abnormally large quantities of nourishment taken and in spite of excellent digestion, the patient may lose weight. The skin is dry and harsh, the temperature frequently subnormal, the pulse frequent and the tension increased.

Complications.—Serious complications are frequent, such as acute pneumonia, tuberculosis, diabetic tabes, hypochondriasis, cataract, diabetic retinitis, impotence; nephritis is quite common, sometimes due to arteriosclerosis, in other cases probably the result of the strain on the renal structure from the continual passage of abnormal quantities of sugar.

Prognosis.—Recovery from true diabetes is very rare. In children, the disease is especially fatal; so-called galloping cases are often seen which carry the young patient off in a few days. With advancing years, the disease runs a slower course. During middle life, diabetes may exist for ten or fifteen years before the fatal termination. In stout individuals, the prognosis is more favorable than in those of slighter build.

Unless one of the many serious complications, to which the patient is exposed, sets in, the disease usually ends with diabetic coma. This condition closely resembles in its onset uremic coma and, like it, is due to the presence in the blood of some toxic agent, which in this case is believed to be acetone.

Treatment.—The diet and personal hygiene of the patient are of prime importance. The patient should live a quiet life, free from excitement and worry. He must be scrupulously regular in his habits, taking a moderate amount of exercise and bathing daily to promote a free action of the skin. The regulation and restriction of the diet is the most essential part of the treatment. The carbohydrates in the food should be reduced and a carefully arranged diet, with due regard for variety, should be given. The substitution of gluten bread for ordinary bread and saccharin for sugar, should be a part of the dietary *régime.*

Among remedies, opium is the one that has specific influence on the progress of the disease. Codein given in one-half-grain doses three times a day, gradually increasing to six or eight grains during twenty-four hours, will in the majority of cases lessen the amount of sugar in the urine materially. As the amount of sugar diminishes, the opium may be gradually withdrawn.

Among other useful remedies, we may mention potassium bromid, arsenite of bromin, arsenic, antipyrin, the salicylates, nitroglycerin and strychnin.

DIET LIST

From Friedenwald and Ruhrah, "Diet in Health and Disease"

FOODS ALLOWED.—Meats, eggs, green vegetables, fats. *Soups:* Chicken, beef, veal, mutton, oyster, turtle, terrapin, clam broth (prepared without flour). *Meats:* All meats, except liver. Gelatin jellies. *Cheese:* All varieties, especially cream cheese. *Fish:* All fish, including oysters, clams, terrapin, lobster, shrimp, salt fish. *Farinaceous foods:* Gluten bread, cakes, biscuits and porridges, almond cakes and bread, soya bread. *Vegetables:* Green vegetables, spinach, lettuce, romaine, chicory, sorrel, kale, artichokes, endives, pickles, cucumbers, cranberries, truffles, mushrooms. *Fruits:* All acid fruits, sour apples, sour cherries, sour oranges, lemons, grape fruit, gooseberries, red currants. *Nuts:* All sorts of oily nuts, such as cocoanut, walnuts, filberts, almonds, butternuts, pecans, Brazil nuts. *Fatty foods:* Cream, butter, olive oil, cod-liver oil, bone marrow. *Drinks:* Tea or coffee without sugar, alkaline mineral waters, Rhine wines, claret, Burgundy, brandy, whisky.

FOODS FORBIDDEN.—Sugars, starchy foods (rice), sweets of all kinds, liver. *Vegetables:* Potatoes, turnips, beets, carrots, peas, baked beans, cauliflower; also sweet fruits, such as dates, grapes, peaches, prunes, bananas, preserves and jellies. *Nuts:* Peanuts and chestnuts. *Drinks:* Sweet wines, cider, cordials, beer, porter.

PHOSPHATURIA

This is a condition in which an excess of phosphates is passed in the urine. Two varieties of phosphaturia can be distinguished, the true and the false. True phosphaturia depends upon an absolute increase in the amount of phosphates eliminated in the urine as determined by quantitative analysis.

A mere deposit of phosphates in the urine immediately on voiding or on standing, without a relative increase in the total amount of phosphates, constitutes false phosphaturia. The clinical diagnosis of true phosphaturia can be made only: (1) If there is a quantitative excess of phosphates which is constant (the normal amount excreted in twenty-four hours does not exceed three and a half to four grains). (2) If this excess is not controlled by a change of diet. (3) If the deposit of phosphates occurs immediately after voiding the urine.

Deposits of phosphates in the urine may occur within the body in cases of inflammation or suppuration of the urinary organs, such as cystitis, pyelitis, etc.; especially when there is a decomposition of the urine within the tract, the result of an obstruction, as an enlarged prostate or a stricture. Of course, such cases cannot, in any sense, be called true phosphaturia.

This form of phosphaturia is of special interest to the genito-urinary surgeon on account of the frequent formation of calculi under these conditions.

The phosphorus eliminated with the urine is derived from two sources: from the food and from decomposition of the tissues, especially the phosphorus containing proteids, as well as nuclein and lecithin.

In the urine, the phosphorus appears in two forms: (1) As earthy phosphates—calcium and magnesium phosphates; (2) as alkaline phosphates—the phosphates of sodium and potassium. The alkaline phosphates are more abundant, the proportion being about two to one.

The earthy phosphates are held in solution in the urine by the diacid sodium phosphate, to which the acidity of the urine is due.

Whenever the acidity of the urine is neutralized, either before or after voiding, the earthy phosphates are precipitated, but they can readily be dissolved by making the urine acid again.

A vegetable diet, by diminishing the acidity of the urine, will often bring about this apparent phosphaturia; while a meat diet, on the other hand, will decrease or cause the disappearance of this precipitate of earthy phosphates by increasing the acidity of the urine.

True phosphaturia, that is, the condition associated with a more or less constant relative increase in the amount of phosphorus eliminated, must be classed as a disorder of metabolism. According to L. J. Teissier, four forms of this disease can be distinguished:

1. Cases with polyuria and with very pronounced disturbances of the nervous system, with or without organic changes in the latter.

2. Cases which are from the beginning or during the later stages of the disease associated with fatal affections of the lungs.

3. Cases in which phosphaturia occurs together or alternate with glycosuria.

4. Cases which cannot be grouped under the foregoing divisions and which alternate with oxaluria and uricacidemia, showing often also a slight albuminuria and a certain relation to gouty states.

Treatment.—The treatment of phosphaturia requires, first of all, regulation of the diet and habits of living, whether the disorder belongs to the true or false variety. Among the remedies that have been used successfully in the control of true phosphaturia, phosphorus is especially recommended, also nux vomica and arsenic.

To control phosphaturia of the false variety, the conditions producing it must be treated. There may be decomposition of the urine in the urinary tract, due to inflammation and obstruction. Many cases of false phosphaturia simply require a more liberal meat diet; others call for mineral acids to correct gastric fermentations and disturbances of the digestive function. If the phosphaturia is accompanied by bacteriuria, urotropin should be given.

The *diet list* for a case of phosphaturia may contain meat, eggs, milk, cheese, cereals and the legumes, whereas the ingestion of fresh green vegetables, fruit and potatoes, should be restricted.

CHAPTER XIX

METHODS OF EXAMINING THE KIDNEY

In the cases that we are called upon to see, we are led to suspect the presence of a surgical disease of the kidney by certain symptoms, foremost of which is a complaint of pain in the loin; second, symptoms referable to urination or the urine voided; and third, constitutional symptoms.

Pain is the most important of these troubles. It may be slight in character and may be present constantly or at intervals, or it may come on as a severe attack of colic located in the loin and extending down the course of the ureter.

Pain is most common in renal calculus, especially after exertion, although it is also present in varying severity in movable kidney, tuberculosis and nephralgic nephritis.

Frequent and painful urination is a bladder symptom and rarely occurs in kidney disease, excepting in renal tuberculosis in cases in which the disease has invaded the bladder. Polyuria is also a symptom of renal tuberculosis.

Hematuria is the symptom of renal disease which, next to pain, alarms a patient the most and is the reason for the consultation. When hematuria occurs in a patient suffering from pain in one loin, it leads us to think of hematuria on that side. Hematuria is most characteristic of renal tumor, in which case it is spontaneous and often very severe. Next in order, it occurs in renal calculus and tuberculosis.

Pyuria in kidney cases means infection, as does also fever, and, therefore, if either or both of these symptoms occur in a patient with pain in the loin, it leads us to think of a septic kidney. With the history of these symptoms, we must begin the examination that will finally lead to the diagnosis of the trouble.

In the examination of a suspected case of surgical kidney, several questions have to be taken into consideration. *First*, Are the kidneys affected or is the trouble in some of the other urinary organs? *Second*, Which kidney is diseased? Is there another kidney? If there is, What is its condition? *Third*, What is the nature of the disease? *Fourth*, What is the functional power of the diseased kidney and its mate? *Fifth*, Is an exploratory operation necessary?

No. 1: The Examination of the Urine.—This is most important when considered in conjunction with other findings. The presence of normal renal products in the urine in an increased amount, or of abnormal products, both point

to a renal disturbance. If we find a very large amount of renal epithelia thrown off, it suggests some *mechanical* irritation of the kidney or its pelvis. If, in addition to this, there are red blood cells and considerable mucus present in the urine, the probabilities of renal irritation are much increased.

The presence of albumin and hyaline casts point either to marked irritation of the kidney or to disease. If these casts are granular and epithelial as well as hyaline, we have reason to believe that a more severe process, a nephritis, exists. If crystals are present in masses of mucus or casts, we are led to think of the probabilities of stone. If, in addition, pus is detected, the indications are that there is an infection of the pelvis; and if pus casts are also found, it is evidence that the parenchyma is also infected.

An increased amount of urine, of low specific gravity, leads us to think of tuberculosis, which the presence of tubercle bacilli would confirm. Atypical cells, tumor fragments and the presence of connective tissue lead us to think of tumor. Blood in the urine in connection with abnormal renal products, suggests tumor, stone, tuberculosis or hemorrhagic nephritis.

While the urinary findings in a large percentage of kidney cases give us the most reliable data upon which to base a correct diagnosis, they are frequently but the first incentive to the thorough investigation of the case and only acquire a definite significance when considered in connection with the results of other methods of examination.

We will assume that, from the urinary findings, we have decided on the presence of kidney disease of a surgical nature and are now desirous of locating the trouble. To confirm the diagnosis thoroughly, a further examination should include the following steps in the order given:

No. 2: In which kidney is the disease located? Is there another kidney, and if so, is it normal or abnormal?

External physical examination, including:

(*a*) Inspection, palpation and percussion.
(*b*) Cystoscopy.
(*c*) Ureteral catheterization.

No. 3: What is the nature of the disease?

(*a*) Radiography.
(*b*) Guinea-pig inoculation.

No. 4: What is the function of the diseased kidney and its mate?

(*a*) Cryoscopy.
(*b*) Injections of methylene blue.
(*c*) Phloridzin injections.

No. 5: Is an exploratory incision necessary?

No. 2: In which Kidney is the disease located? Is there another kidney, and if so, is it secreting? If it is secreting is the urine normal or abnormal?

(*a*) Inspection, Palpation and Percussion.

Inspection sometimes shows a bulging in the loins and recalls to our minds the possibility of hydronephrosis, pyonephrosis, tumor of the kidney, perinephritic abscess, or rupture of the kidney. A bulging on one side of the umbilicus would point to a movable kidney. Very little, however, is learned by inspection.

Palpation is, on the other hand, a most important method of examination, as by this means we notice undue mobility in movable kidney, and enlargement when tumor, hydronephrosis, pyonephrosis, pyelo-nephritis, perinephritic abscess, or a cyst is present. By palpation, tenderness is also discerned, indicating a congestion of the kidney, or inflammation, as pyelitis, pyelo-nephritis and pyonephrosis. A normal kidney in its normal position cannot be felt through the abdominal wall.

Methods of Palpating the Kidney.—The kidney is usually palpated in one of three ways: With the patient lying on the back with the knees flexed; in a sitting posture; or lying on the healthy side. (See chapter on Examination of Patients, Figs. 233, 234 and 235.)

Palpation with one hand will sometimes show us a movable kidney or one that is enlarged. The bimanual method is, however, the most practical and gives us a better idea of its size, consistence, mobility and the presence or absence of renal tenderness.

When the patient is examined lying flat on the back with the knees flexed, the examiner stands on the side to be explored, facing the patient. If the right side is to be examined, the right hand is on the front of the abdomen on the outer side of the rectus abdominis muscle and the left hand is on the outer side of the erector spinæ, just below the twelfth rib.

The patient is directed to inspire and expire deeply and, during the moment of relaxation when the patient is breathing out, the hand on the abdomen pushes firmly toward the posterior abdominal wall, in an effort to reach the hand that is placed posteriorly. The part of the hand used in examining is the palmar surface of the finger tips. If any surgical condition of the kidney is present, a sensitiveness is evident, while the normal kidney is not tender to the touch. Movable organs can be felt to glide from under the finger tips and can usually be held by anterior pressure above them and palpated wholly or in part. (See Fig. 233.)

Ballottement of the kidney is the pushing of the organ from the finger tips of one hand to those of the other, and *vice versa*, by a series of jars or by gentle bimanual palpation. By this means, an enlarged organ is distinctly felt and can be outlined and any tenderness noticed.

The *lateral method* of palpation consists of placing the patient on the healthy

side with the thighs antiflexed and the examiner standing behind the patient's back. In examining the right kidney, the right hand is placed on the front of the abdomen and the left behind, the same as when examining a patient who is placed in the dorsal position. The left hand is often removed from behind and placed in front just below the free border of the ribs, as in cases of movable kidney. Pressure made at this point in front, sufficiently deep to prevent the organ from returning to its fossa, will allow the examiner to outline it more easily with the right hand.

The organ is often palpated in this manner with greater accuracy, and its size, consistence and the character of its surface better determined. Kidneys are not so easily mistaken for the liver by this means, as we do not have to examine over the edge of the latter organ. (See Fig. 235.)

The kidney can often be more easily felt in the sitting posture than when the patient is lying down, especially in the case of movable kidney. The hands should be in the same position in relation to the patient when the examination is made in the sitting posture as when it is made lying on the back. (See Fig. 234.)

I think that, in palpating the kidney, any position or method should be used which best enables the examiner to accomplish his purpose. I always examine the patient on a chair-table and change the position of the patient while making the examination from the sitting to the horizontal position. When there is a movable kidney, the organ often drops down when the patient is in the sitting posture; or else it can be made to drop by having the patient cough or by jostling that region. In such a case, if pressure is made by one hand just below the ribs in front, and the back of the table is lowered while the patient is perfectly relaxed, the organ is prevented from slipping back into its fossa again and can be easily outlined by the other hand.

The standing position, with the patient resting the buttocks against a table or chair, will often enable us to palpate the organ in a satisfactory manner.

Percussion is of value in a negative way, as tympanitic resonance over the anterior surface of an abdominal tumor situated in the loin, when the patient is in a dorsal position, points to its renal origin, on account of the intestine being placed in front of it. Sometimes, if there is a dullness over a tumor in the loin by anterior percussion, when the patient is in the dorsal position, it is an advantage to inject gas into the colon in order to bring out the relation between it and the tumor; for, if it then becomes tympanitic, it will show that the tumor is behind the colon and therefore, probably, renal.

Liver dullness is not affected by gas in the intestine, while the kidney dullness is obliterated.

The routine examination of the patient tends to clear up, to a considerable degree, the question of whether the kidneys are alone involved or not, in cases in which this has not already been done. The patient passes urine into a tube,

and, if the urine is clear and contains no shreds, it shows that there is no suppurative involvement of the urethra or the tract above it.

If the first urine is turbid and the second is clear, it shows that the turbidity is due to some trouble in the urethra, the prostate or vesicles that empty into it, while the clear second urine shows that there is no marked suppuration in the bladder or kidney.

If both the first and second urines are turbid and the first contains shreds while the second does not, it shows that the urethra is inflamed and that the bladder or kidneys are also involved, unless the turbidity is due to phosphates or bacteria. When there are such results, therefore, the urines should be examined for phosphates or bacteria (see chapter on Urinary Examination), as well as for pus and inflammatory products from the bladder and kidneys.

The physical examination just made has, perhaps, given us some idea as to whether one or both kidneys are involved and has brought us one step further forward in our systematic examination of that organ. The patient's urethra should then be examined for strictures and his prostate for enlargement, as all obstructions favor the development of cystitis and suppurative diseases of the kidney. The patient's bladder should now be washed out, filled and the cystoscope introduced.

(*b*) Cystoscopy.—When the fluid medium is clear, as is shown by examining the washings from the bladder in a glass held before the light, the interior of the organ is examined with the cystoscope. If there is no tumor, stone, tuberculosis, ulceration or inflammation present, the bladder is known to be healthy and the mouths of the ureters should be examined to see if both are present. In case both ureteral mouths are seen and clear urine comes from each, we know that both organs are present and that the kidney trouble is either aseptic or but slightly septic. If there is an aseptic disease of one or both kidneys, the fluid in the bladder will remain clear. If the fluid quickly becomes opaque, it is a sign that pus is coming from the kidney; or pus flocculi or blood may be seen coming from the mouth of one of the ureters and not the other, showing that there is a disease in the kidney from which the abnormal products come.

(*c*) Ureteral Catheterization.—If the urinary examination has shown pathological renal findings of an aseptic nature and the cystoscope has shown clear urine coming from each kidney, the ureters should be catheterized to obtain a specimen from either kidney, in order to discover which kidney is sending forth the pathological products that were noticed in the general urinary examination, and, in case both contain such findings, to ascertain the degree of the involvement in each specimen. The passing of the ureteral catheters will also tell if the ureter is of normal size up to the renal pelvis and, if not, the nature and location of the obstruction.

If one ureter is not seen to excrete, we become suspicious as to the presence of the kidney on that side, and, if on catheterizing the ureter we find it goes into the renal pelvis and nothing comes away, we suspect a nonfunctionating kidney. If the ureteral catheter goes up but a slight distance and no urine comes through it, we do not know whether there is an obstruction of the ureter on that side that has caused an atrophy of the organ, or whether there is a congenital absence of the kidney. In either case, the patient would, of course, have but a single working kidney. In case a turbid and flocculent urine is seen coming from one kidney while that from the other organ is clear, specimens of each should be taken, and after examination the result should be compared with that of the general urine. The same test applies to purulent urine coming from both sides.

In case both ureters are seen to be secreting urine and yet one ureter cannot be catheterized, the catheter should be left in the permeable ureter, and an ordinary small soft-rubber catheter should be passed into the bladder; after emptying it, the rubber catheter should be retained in order to collect the specimen coming from the ureter that could not be catheterized.

If the bladder has been found, during our cystoscopic examination, to be diseased, we should note this condition and also the presence or absence of urethral stricture, hypertrophied prostate, vesical calculus, tuberculosis or tumor, all of which are guides to the diagnosis of diseases of the kidney. Small ulcers grouped about the mouth of one ureter point to a tubercular kidney on that side.

It may be here stated that suppurative disease of the kidney, when due to some cause not situated in that organ or its pelvis, is more frequently secondary to urethral stricture, hypertrophy of the prostate, or vesical calculus than to any other causes.

By the means just outlined, we will be able to discover the presence of urethral, bladder, ureteral or renal diseases, and to know which of these four points of the urinary tract is involved; or whether two or more are affected; and, if the disease is renal, to know which side is involved and to form a fair idea of the condition of the other organ. We can also judge in a case of renal disease, whether or not the trouble is due to lesions situated lower down in the urinary tract, as obstructions or other troubles in the urethra, prostate, bladder or ureters. The comparison of the specimen obtained from each ureter with that of the general specimen from both kidneys, together with the general and special examinations already outlined, will probably tell at this time what the condition of each kidney is and the nature of the disease. Single (unilateral) kidneys and nonfunctionating kidneys are very rare. There are, however, certain tests still to be used, the positive results of which are confirmative of our present conclusions.

No. 3: The Nature of the Renal Disease.

(*a*) Radiography.—If there has been a pain in the renal region on one side, if hematuria has followed the pain, if the kidney has been found to be tender or enlarged, if crystals have been found in the urine in masses of mucus and epithelia, we suspect a case of aseptic nephrolithiasis. If there is a large kidney on one side that is painful and tender with the same findings that have been mentioned above plus attacks of fever, pus and granular, epithelial and pus casts in the urine, we must look for a case of septic nephrolithiasis. The suspicion of renal calculus becomes a probable diagnosis if no obstructions to the urinary flow have been discovered in the urethra or prostate, nor any tubercle bacilli or tumor fragments have been found in the urine. We, therefore, proceed to radiograph the patient.

Radiography should always be resorted to when there is the slightest suspicion of stone and also in all pus cases for which there is no appreciable cause. Stones cannot always be detected by radiography, even by the most improved technique; but in a large proportion of cases, the shadows have been successfully detected and a positive diagnosis of calculus in the kidney or ureter is generally conclusive by the X-ray.

The difficulties to be surmounted in this work are not only the imperfections of the apparatus, excessive fat in the patient, accumulation of feces in the bowel, malformations of the kidney and very small stones located in the renal tissues; but also the permeability of renal stones to the X-rays, which is sometimes so great that they throw but a faint shadow. This is especially so in cases of uric-acid calculi, the most common kind. Stones of oxalate of lime and phosphates usually throw a shadow and even small amounts of calcium oxalate will throw excellent shadows.

If the picture is of good quality and if successive pictures taken at intervals of a few days indicate the presence of stone, the surgeon is able to make a positive diagnosis. The radiographist should, however, be able to take pictures of a proper quality, and also to interpret them correctly. At least two pictures, showing good shadows of stone, should be obtained, before a positive diagnosis is made for the purpose of operation.

Lester Leonard, of Philadelphia, and Caldwell and Cole, of New York, have, by their extremely good work, been able to obtain positive findings in nearly all cases in which calculus was found to be present on operation. Kümmel, of Hamburg, has been exceptionally fortunate in his X-ray work and has concluded that every stone in the kidney can be detected by a good X-ray plate, of whatever composition the calculus may be.

The important points in obtaining satisfactory results is to have proper plates and the requisite technique. In the first place, the bowels of the patient should be thoroughly emptied, so that there can be no fecal accumulation in the colon over the kidney. Calomel should be taken the night before, a saline laxa-

tive in the morning and a high cleansing enema after the bowels have moved, after which the picture should be taken. The patient should be placed in the correct position and submitted to the proper exposure.

The shadows usually lie from four to ten centimeters to one side of the middle vertebral line, in a location corresponding to the second lumbar vertebra, at which point the pelvis of the kidney is usually situated.

The patient is placed in the dorsal position, the knees and thighs flexed, and an adjustable tube of medium softness is used at a distance of 15 cm. (6 inches) from the abdominal wall. The abdomen is covered with a red screen, limiting the area exposed to that of the renal region. A photographic plate is placed under the patient's back, corresponding to the opening in the screen. The exposure should be short—about one or two minutes. A shadow over the suspected kidney usually makes the diagnosis of nephrolithiasis certain.

(*b*) Guinea-pig Inoculations.—In the case of a patient with pain, an enlarged tender kidney on one side (and polyuria and frequency of urination), in whose urine no tumor fragments are found coming from that side and no shadow is seen on radiography, tuberculosis of the kidney is suspected, especially if the individual is losing weight and strength. If tubercle bacilli are found in the urine coming from the suspected kidney of this patient, the diagnosis is confirmed; but in case the urine from that kidney does not show tubercle bacilli, it should be at the same time injected into guinea pigs. In fact, the urine from both kidneys should be examined for tubercle bacilli and injected into guinea pigs.

Guinea-pig inoculations are just as important in renal examinations in cases in which tuberculosis of the kidney is suspected, as is the X-ray in cases in which nephrolithiasis is suspected. The details of guinea-pig inoculations have been described in a chapter on Tuberculosis of the Kidney, and also in the chapter on Examination of the Urine to which the reader is referred. The positive findings in guinea-pig inoculation are, to-day, an indisputable proof of the presence of tuberculosis in a kidney.

In other cases in which the kidney on one side is enlarged and the patient has marked attacks of hematuria, tumor of the kidney is suspected. If after examining the urine from the affected side in such a case, crystals and tubercle bacilli are not found and guinea-pig inoculations and radiography are negative, tumor of the kidney is probably present, and this diagnosis would be confirmed by the finding of atypical cells and tumor fragments in the urine from that kidney.

The examination thus far has shown how we have arrived at the conclusion that a kidney is diseased, which kidney it is, the nature of the disease, the condition of the other kidney; and it now remains to test the function of the two organs and to determine their secreting power.

No. 4: Functional Capacity of the Kidneys.—The capacity for work, or the functional efficiency of an organ, is an index to its health from a physiological point of view. An organ may be, to a certain extent, diseased and yet able to perform its function satisfactorily. The functional efficiency, or inefficiency of an organ, may or may not be proportionate to the anatomical lesions. It is important to know what lesions are present in the kidney and still more so to know the amount of functional efficiency left in the diseased kidney, as well as in the organ of the opposite side.

It is said that a patient can live with a third of the total amount of functionating renal tissue normally present in both kidneys, but that if there is only one fourth of the total functionating renal tissue left, he will die. It is safer to have a remaining healthy kidney that contains one half of the total amount of the normal kidney tissue of both kidneys than one that contains but one third; but it is also safer to have a remaining kidney with one third of the total amount of renal tissue than one with but one fourth, as, in the last case, there would be a renal insufficiency that would be fatal.

By a nephrectomy, we remove the diseased kidney tissue, so that the remaining kidney is relieved of the reflex and toxic influences that the organ has had upon it. The function of the remaining kidney improves and it shows itself adequate to the needs of the individual.

In surgical affections, the comparison of the functional state of one kidney with that of the other is of paramount importance. The removal of one kidney which may be functionally useless as the result of a tumor, tuberculosis, etc., is not a dangerous procedure if the remaining kidney is perfectly healthy, as it will then be able to take care of the work of both. If the opposite kidney is the seat of either the same or of other disease, the removal of the diseased organ is contraindicated. Occasionally, however, the disease in the less affected organ is so slight that its functional power is sufficient to carry on successfully the elimination of the total urine after the removal of the more diseased one. Modern surgeons for this reason avoid the removal of any kidney unless the functional examination of the other organ shows it to be sufficiently healthy. To a certain degree, a clew to the pathological lesions and to the amount of work a kidney can do is obtained by the chemical and microscopical examination of the urine. Yet this examination is not always sufficient, even when the urine from each kidney is tested separately to determine the condition of each organ.

Estimating Renal Function in Surgical Diseases of the Kidney.—In order to determine the functional capacity of the kidneys, a twenty-four-hour specimen should be examined. This will tell us the amount of liquid and the amount of solid passed. The most important solid is urea and, therefore, this should be taken principally into consideration.

Knowing the normal amount of fluid passed in twenty-four hours, as well as the amount of solid the urine contains, it will be easy to compare the total

urine from the patient with the normal, as well as the total amount of urea passed. Low specific gravity does not mean much, if the amount of solid is sufficient in a twenty-four-hour specimen, as a diseased kidney will often give off more fluid than a healthy one, and nervous individuals with healthy kidneys may also have polyuria. The amount of urea in a catheterized specimen from each ureter, if the catheters are allowed to remain in twenty-four hours, compared with the general twenty-four-hour common specimen of voided urine, would give us a good idea of the amount of urine and urea secreted from each kidney, and whether, in case the diseased kidney were removed, the remaining organ could carry out satisfactorily the renal function of elimination. Generally, however, the catheters are left in but one hour and an estimate is made between the amount secreted in this time and that passed in twenty-four hours.

THE COMPARATIVE FLOW OF URINE THROUGH THE URETERAL CATHETERS IN EXAMINING THE KIDNEYS.—It is important, while the catheters are in the ureters, to note the rapidity and amount of the urine coming from each organ. A normal kidney secretes about an ounce an hour and the urine flows in a rhythmical manner. If, on introducing a ureteral catheter, an ounce or more urine quickly escapes, it shows a dilatation of the pelvis and renal retention, occurring either in uronephrosis or pyonephrosis. The turbid urine may be white in color, milky, or it may have a yellowish tinge. When white, there is but a small amount of solid present, when darker a more concentrated urine. The very light colored urine occurs in cases of pyonephrosis in which the kidney parenchyma has been almost entirely destroyed. Sometimes nothing but very thick pus comes from the ureter and slowly drops from the end of the ureteral catheter, showing that the kidney parenchyma is practically destroyed, that the pelvis is not much enlarged and the kidney is secreting but little or no fluid.

Sometimes a diminished amount of turbid amber or yellow urine comes from one kidney and an increased amount of turbid white urine from the other. In this case, both kidneys are diseased, probably the first with pyelitis or pyelonephritis and the second with pyonephrosis. The kidney secreting the turbid darker urine, would probably be the more acutely involved of the two, but would contain more functionating renal tissue. In such a case, the general urine coming from both kidneys might be the color of lemonade. A general urine might also resemble lemonade when normal urine is coming from one kidney and a white turbid urine from the other. Again, a general urine may have a lemonade color in case one kidney is the seat of parenchymatous nephritis, and the other kidney almost destroyed by pyelo-nephritis or pyonephrosis. On the other hand, one kidney may secrete a larger amount of urine of a very low specific gravity, and the other a turbid-colored urine of a higher specific gravity.

These variations of the balance of health and disease in the kidney, as shown by the urine, are more likely to occur in tubercular affections of the kidney than in any other. In determining the renal function of the two kidneys, it is

necessary to compare the findings in the urine from one kidney with those of the other, as well as with the findings of a specimen taken from the entire twenty-four hours' output of urine.

(*a*) CRYOSCOPY.—It has been proved experimentally that the freezing point of a solution is lowered in proportion to the number of molecules dissolved in a given volume of the solution, no matter what the weight of the individual molecules may be.

Therefore, the freezing point of the blood or the urine indicates the number of molecules dissolved in a given volume of the sample.

The freezing point of normal urine varies between $-1.3°$ and $-2.2°$ C. When the kidneys are diseased, the theory is that fewer molecules of solids are excreted and so the freezing point is higher—that is, nearer to 0°. A freezing point in urine higher than $-1°$ C. is usually regarded as abnormal. When the kidneys are almost destroyed by disease, as, for example, shortly before death from uremia, the freezing point is often very nearly at 0°, which is the freezing point of distilled water.

Cryoscopy is, therefore, designed to give us a means of estimating the functional capacity of the kidney.

Technique.—Sample of urine, twenty-four hours'.

Amount needed, 10 to 15 c.c.

Apparatus:—Cryoscope, consisting essentially of a very delicate thermometer of a special pattern known as Beckmann's. The invention of this thermometer made the delicate measurements of temperature possible which are now used in chemical physics.

The freezing of distilled water (zero) should always be determined first with such a thermometer and any deviation from zero should be noted as a correction.

The other parts of the apparatus are: A test-tube in which the urine is placed, the thermometer fitting into this tube through a perforated rubber stopper. A wire or hard-rubber stirrer spiral is used to mix the urine during the operation. Outside of the tube is the receptacle for the mixture of ice and salt usually employed for the freezing process.

To read the thermometer, the observer watches the mercury constantly from the start. The mercury will suddenly begin to sink and then will stop quite low on the scale. Then it will begin to fluctuate rapidly and will rise to a point were it will remain stationary. This is the freezing point of the urine examined. It is, of course, very important to wait for the "superfusion" to cease, as accurate readings cannot otherwise be obtained. By practicing with distilled water, one can accustom oneself to bring a mixture of salt and ice to a fairly constant temperature. This outside temperature should be about two degrees below zero and another thermometer may be used to regulate it.

The *error* in reading should not be over $\frac{2}{100}$ of a degree. This is accurate enough for clinical purposes.

Clinical Applications of Cryoscopy.—The clinical value of the method is naturally limited, owing to certain sources of error, such as imperfect technique and variations in the normal freezing point, and owing to complicated lesions of the kidney, such as complete destruction of one part of the kidney with corresponding hypertrophy of another part, etc.

The chief value of cryoscopy lies in the determination of the relative freezing point of the urine of each kidney separately, obtained with the aid of the ureteral catheter.

Another, though less important use of the cryoscope is in the diagnosis or prognosis of a cystitis or pyelitis when we wish to know if the process is ascending into the kidney.

Cryoscopy of the Urine and the Blood.—The freezing point of the blood is determined in the same manner as that of the urine and the two tests are used as a check upon each other. Keranyi and others found that normal blood freezes at about $-0.56°$ C., a figure which is remarkably constant. When the kidneys are diseased and do not excrete as much effete material as normally, an increased amount of toxic substances accumulates in the blood and thus the freezing point of the blood becomes lowered. Abnormal kidneys, therefore, produce a lowering of the freezing point of the blood. It has been found that when this point is below $-0.60°$ C., the kidneys are diseased.

(1) When the freezing point of the blood is normal and when the freezing point of the opposite kidney is also normal, the surgeon can safely extirpate the affected kidney.

(2) When the freezing point of the blood is normal and that of the urine of the opposite kidney does not fall within normal limits, the surgeon should perform a conservative operation, such as nephrotomy, instead of nephrectomy.

(3) When the freezing point of both blood and urine of the opposite kidney are abnormal, the surgeon should perform even more conservative operations (e. g., incisions of nephrotic sacs) only under the stress of dire necessity.

(*b*) METHYLENE-BLUE TEST.—The object of this test is to determine the rate of excretion of methylene blue through the kidneys, in order to estimate the functional value of these organs. The coloring matter is injected intramuscularly in a five-per-cent watery solution. Normally, the blue color should appear in the urine in half an hour after injecting it. If the appearance is delayed to an hour and a half or longer, the kidneys have a diminished permeability.

While the test is attractive theoretically, it is, unfortunately, unreliable clinically. One objection is, that so long as a small amount of parenchyma remains healthy, as is often the case in an extensively diseased organ, enough methylene blue will appear in the urine promptly after injection. It seems,

that some kidneys may have a certain selective action upon methylene blue, even though diseased, and that they excrete the dye readily, even though they may not be capable of excreting the urinary constituents. Conversely, it has been found at times that the kidneys may act normally so far as excreting urine is concerned, but cannot excrete methylene blue promptly.

Another source of error is the fact that methylene blue may be reduced in the tissues to a chromogen which is excreted as such, and is converted again into the blue or greenish dye by boiling the urine with acetic acid.

The duration of the excretion of a given dose of methylene blue is also an uncertain index. The duration may be shortened, the methylene blue being excreted more rapidly than normally in both acute and chronic parenchymatous nephritis, while it is lengthened frequently in the interstitial form. The lengthening of the period of excretion may also be due to compensatory hypertrophy of the healthy kidney. In the acute and chronic parenchymatous forms, as well as in amyloid kidney, the excretion is not materially modified. While the test may be useful in distinguishing the side affected by comparing the urines of either kidney, it is not a trustworthy guide as a general standard for the functional value of the kidney.

Technique of the Test.—One c.c. of a five-per-cent solution of chemically pure methylene blue is injected deeply into the buttock. The patient is directed to empty the bladder every quarter of an hour and the urine is collected in separate glasses. The time of beginning elimination, the duration and amount of coloring matter excreted are noted. Each sample must be tested with boiling acetic acid, in order to convert the chromogen that may be present into methylene blue. If the dye appears within half an hour, the kidneys are supposed to be normal. The elimination lasts normally from thirty-five to sixty hours.

(*c*) The Phloridzin Test.—This test is based upon the fact that, when phloridzin is injected into the circulation, sugar is excreted by the kidney and appears in the urine.

This test is performed by injecting subcutaneously 1 c.c. of a 1 : 200 solution, that is, 5 milligrams of the drug. The patient is allowed to urinate before the injection and his urine is tested to see that it contains no sugar. The urine is then collected each quarter of an hour and each sample is tested for sugar. The urine is cleared first by thorough filtering.

Normally, sugar appears within half an hour to an hour, disappears within three or four hours and the total amount excreted is from one to two grams. In chronic nephritis, with interstitial changes, the excretion is either diminished or abolished, even when no albuminuria is present.

Israel objects to the phloridzin test and denies that the amount of healthy parenchyma is indicated by the amount of sugar excreted. But even if the glycosuria is not a measure of the work of the kidney, when there is a marked difference in the amount of sugar excreted by either kidney, we can determine

which of the two works better. When this difference is very marked with a very low amount of glucose on one side, we are justified in concluding that this particular kidney is probably functionally insufficient.

Having given the urine the functional tests, in addition to the remainder of the examination, we can feel that everything has been done that is required in order to determine the condition of the healthy and the unhealthy kidney, excepting, perhaps, an exploratory incision.

No. 5: Exploratory Incision.—An exploratory incision is rarely necessary. There are, however, cases in which we must resort to it, on account of an extremely contracted bladder, hemorrhagic cystitis, sacculated bladder, or such an unusual amount of blood or pus in the urine coming down from the kidneys that we cannot see the ureteral mouths or the urine coming from them.

Such difficulties to cystoscopy and ureteral catheterization are seldom encountered, but they are occasionally met with in cases in which there is an enlargement of the kidney on one side with findings of renal disease in the urine, and, besides, constitutional symptoms that call for operative interference in the case of the enlarged organ. Here an exploratory incision should be made on the side of the suspected healthy kidney to examine it before operating on the suspected diseased one.

CHAPTER XX

ANOMALIES OF THE KIDNEY

ANOMALIES of the kidney gland proper, and of the renal blood vessels, are intimately linked embryologically with the anomalies of the ureter. They are all congenital and explained by embryology. Major abnormalities are rare; but minor anomalies—small deviations from the normal type—are, on the contrary, rather common. The complexity of the developmental process of the upper urinary tract, which is very intricate, easily accounts for the frequency of the minor defects.

The subjects can be treated here but briefly and, in case our readers desire further information, we refer them to the "Surgical Diseases of the Kidney and Ureter," by Morris (London, vol. i, p. 18).

Some abnormalities have great surgical importance, while others have only an anatomical and embryological interest, and represent transitory fetal stages which have become accidentally permanent.

ANOMALIES OF THE KIDNEY GLAND PROPER

Anomalies of the kidney gland proper may be classified under four headings.

A. Anomalies of Position.—Congenital ectopic kidneys have been found at the sacro-iliac joint, which will be shown later in the chapter on Hydronephrosis, over the promontory of the sacrum, just below the bifurcation of the aorta, and in the false pelvis just above Poupart's ligament. Such a kidney may be single or, what is more frequent, associated with another normally developed and normally placed kidney. The vessels are short and multiple, and spring abnormally from neighboring blood vessels, thereby differentiating such a congenitally misplaced kidney from an ordinary movable kidney secondarily fixed by adhesions. The ectopic kidney is fixed in its position and adhesions may be present, but the origin of the vessels is evidence of a congenital anomaly. The organ may be found in any part of the abdomen, or in the pelvis, and this is usually associated with other congenital abnormalities of the genito-urinary organs. It is more common in males than in females.

Kidneys displaced into the pelvis may give rise to disturbances of defeca-

tion and also of urination, such as frequent micturition and tenesmus; hematuria and pyuria are also seen in these cases. The displaced organs become the seat of hydronephrosis or pyonephrosis, with symptoms of pelvic or abdominal tumor. The diagnosis can be made theoretically by a pelvic examination per vagina or per rectum. The introduction of a ureteral catheter also assists, by showing that the ureter appears short and obstructed; but an exploratory laparotomy is necessary for a correct diagnosis, as this will allow us to find the absence of the kidney in the renal fossa, and its presence in the pelvis. If, in a woman, the organ is so placed as to interfere with childbirth, and if the opposite kidney is not diseased, it is best to remove the displaced gland, providing this can be done without too much tearing of the surrounding adherent structures. Cragin removed such a kidney by the vaginal route. Israel, in operating on such a case, closed the abdominal wound made for exploratory purposes and performed an extraperitoneal nephrectomy. Misplaced kidneys are ectopic. Displaced kidneys are movable kidneys that have fallen from the renal fossa and become fixed where they finally lodged.

B. Anomalies in Mobility.—These comprise the cases of congenital movable kidney. They occupy an intermediary position between an ectopic kidney and an acquired movable kidney. There are two types, according to the normal or abnormal origin of the vascular pedicle, and the length of the latter. Sometimes the kidney, instead of being held against the posterior abdominal wall by the péritoneum in front of it, has a true mesonephron.

C. Anomalies in Shape.—The most frequent is *lobulation*. It is due to the persistence of a transitory fetal disposition and reproduces the type of kidney normal in some species of animals. The fissures may be so deep as to give the impression of a multiple kidney. According to Küster, fetal kidneys are subject to tuberculosis, and his opinion is confirmed by other authors. These fissures will be noticed in the illustration of single congenital unsymmetrical kidney. (See Fig. 265.)

Hour-glass contraction occasionally occurs, but it is very rare.

Sometimes there exists a fusion of two homologous poles of both kidneys, the lower ones generally, the upper more rarely. This gives rise to a horseshoe kidney, two subvarieties of which are the sigmoidal kidney and the discoidal, placentalike kidney.

Horseshoe kidney usually shows an isthmus and two free ends which point upward. Less frequently, the two ends point downward, the upper poles of the kidney having coalesced. One of the kidneys may be much larger than the other, and often the bridge or isthmus is composed merely of fibrous tissue. The ureters are usually two in number; sometimes four are present, and run across the isthmus from above downward.

Horseshoe kidneys are usually displaced downward and toward the median line, as low as the sacral promontory. Supernumerary renal vessels often occur

in these cases, and a central renal artery may spring from the aorta and supply the isthmus.

Clinically, horseshoe kidney is of importance on account of the possibility of an operator inadvertently removing the whole mass as one kidney. Partial excisions of horseshoe kidneys have been done by Socin, König and others and the isthmus has been severed after ligating it, or the hemorrhage has been stopped with the cautery.

The diagnosis of a horseshoe kidney is not simple, and at best we may surmise the presence of this anomaly when we feel an abnormal median renal tumor, or see the shadows of calculi very close to the spine. Sometimes a horseshoe kidney can be felt as a pulsating tumor over the aorta, over which a systolic murmur is heard. Hydronephrosis sometimes occurs in a horseshoe kidney. An exploratory incision is the only positive means of diagnosis.

Both poles of both kidneys may be fused, forming a variety known as *annular kidney*, often called solitary kidney and considered as a single kidney. This we believe to be unjustified, as there are two kidneys and two ureters, and this anomaly is simply an exaggeration of the horseshoe type.

D. Anomalies in Number.—Cases of supernumerary kidneys are few and not always well authenticated. The mode of development of the ureter and kidney makes one doubtful as to the possibility of supernumerary kidneys.

Much more important than the anomaly of excess is the anomaly of default. The absence of both kidneys is only a teratological curiosity of the first months of embryonic life. The absence of one kidney, either on account of nonformation, or of congenital atrophy, is the chief anomaly of the kidney from a surgical standpoint.

Statistics show that single kidneys are very rare, although sometimes they appear to be frequent. This is conclusively shown by my own experience with the anomaly.

During the eight years that I spent teaching anatomy and operative surgery at the Post-Graduate Medical School, with large numbers of cadavers always in use, in which both kidneys were dissected or operated upon, I failed to see one instance of single kidney, and this, together with the same experience in numerous autopsies, led me to believe that such a condition almost never existed; I changed my opinion, however, when I encountered three single kidneys in a small hospital service within a period of less than ten months, during which time only fifteen autopsies had been performed. This is certainly unusual, when Guy's hospital reports say that in 4,632 cases, only one congenitally single kidney was found in a period of ten years.

A single kidney may be associated with deformity of the organ or another form of anomaly, lobulation. This point is important to remember when operating, as when one is not sure that there is a second kidney, suspicions may be aroused by an abnormally large and lobulated kidney on the side operated upon.

The situation of a single kidney varies considerably: it may be found in the loin, or in the median line, at the brim of the pelvis, etc. It is usually larger than normal, when in a healthy state, and may also be enlarged from disease. It is generally found on the right side and more commonly in men.

The renal vessels are usually absent on the side where the kidney is lacking, and the ureter as well. Wankiewicz collected statistics of 234 cases of single kidney, showing rudiments of the ureter in 17 cases, absence of the kidney on the left side in 127 cases, and on the right side in 97 cases, while in 12 the side was not given; malformation of the bladder in most of the cases; no trace of a ureteral orifice in the bladder on the side where the kidney was absent in 74 cases, while in others a small indentation or diverticulum was found where the ureter should have been; absence of one half of the trigone in some cases, and, in others, termination of the single ureter in the center of the bladder. According to Wankiewicz, therefore, absence of a ureteral mouth occurs in one third of the cases of single kidney and may then be detected by the cystoscope. A single kidney may be excluded only when both ureters can be catheterized and are shaped to discharge urine.

Fig. 265.— Minute Tubercular Abscesses of a Single Asymmetrical Kidney. Note the deep fissures and convolutions; it was 5½ inches long and very thick. (Author's case.)

A single kidney is interesting surgically, because it may become the seat of an affection demanding nephrectomy, such as tuberculosis or cancer. The following case is an example of the kind and carries out the views of Küster in that it was a lobulated kidney of the fetal type with deep fissures and the seat of tuberculosis. The patient was on my service at the Columbus Hospital.

Case I.—Laborer, aged twenty-one years, was referred to me for nephrectomy for tuberculous kidney. Incision in the left loin showed a large left kidney almost divided in halves by a fissure and completely riddled with small tubercles and abscesses. I removed the organ and the patient died of uremia on the eighth day after nephrectomy. The right kidney was found congenitally absent, as was the suprarenal capsule on that side. Fig. 265 shows the appearance of the extirpated single kidney. This organ was $5\frac{1}{2}$ inches long, 3 inches wide and $2\frac{1}{2}$ inches thick. The kidney resembled a large ripe tomato, only of a deeper red color. It was lobulated, there being four quite distinct lobules. The fissures

between these lobules did not extend through the organ. The organ was mahogany red and studded with small tubercular abscesses under the capsula propria, varying in size from a pin point to a split pea. The upper pole was larger and more involved. The kidney had much fat attached to its capsula propria; there was but one pelvis and one ureter present.

Microscopical Examination.—The kidney showed intense inflammation and numerous miliary tubercles and abscesses, degeneration of the epithelia of the tubules, little new connective tissue, periarterial extravasation of leukocytes, epithelia of the glomeruli thickened and the tubules filled with casts.

In the place of the right kidney, there was an extension of the right lobe of the liver down to the renal fossa on that side, resembling a tongue, about 3½ inches in length, 3 inches in width at its upper part, gradually ending in the shape of a wedge, slightly twisted on itself. No other abnormality was noticed.

When an affection developing in a single kidney can be treated conservatively, as calculus hydronephrosis or pyonephrosis, the outlook is not so gloomy, although if the calculus were to obliterate the ureter, complete anuria would immediately ensue. A single kidney may be present in persons who are in perfect health, and an advanced age may be reached with only one kidney; but it seems that these kidneys, despite their compensatory hypertrophy, are weaker and more liable to disease than ordinary normal kidneys. There is said to be a tendency to albuminuria in young persons with a single kidney, and also a tendency to the formation of renal stones. Hydro- and pyonephrosis from undiscovered causes, and chronic nephritis, have also been recorded in single kidneys. It should be noted that, in the two following cases, the diseases from which the patients were suffering were in themselves sufficient cause for death, and yet in both cases the kidneys were diseased. In these two cases, the patients were in the prime of life and it is not illogical to suppose that the single kidney created a physiological inferiority, partly responsible for the fatal outcome.

Case II (On the service of Dr. C. H. Lewis, at the Columbus Hospital).—Fireman, aged thirty, died of empyema. Autopsy revealed the presence of a single kidney situated on the left side. The right kidney and ureter were absent. The left kidney was in normal position, 7½ inches long, 4 inches wide, 2½ inches thick; it was not distinctly lobulated, but there were depressions upon it, giving rise to irregularities on the external surface. The lower lobe was wider than the upper. Neither kidney nor ureter was found on the other side.

Microscopical examination made by Dr. Noyes showed degeneration of the epithelia in the tubes, and casts, little new connective tissue, few red blood corpuscles, glomeruli showed some cheesy exudation in capsule periphery, connective-tissue proliferation (Fig. 266).

Diagnosis.—Acute parenchymatous nephritis.

Case III (Occurred in the Medical Ward of the Columbus Hospital in the service of Dr. Keller and is published by his permission).—Laborer, twenty-

five years old. Diagnosis, typhoid fever. Died at hospital in the third week of the disease. The autopsy showed that but one kidney was present, situated on the right side, somewhat lobulated, with single pelvis and ureter; on the left side, neither kidney, ureter nor suprarenal capsule was found. The kidney

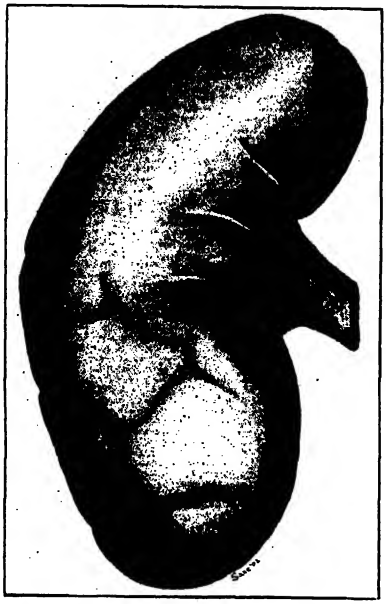


Fig. 266.—Single Asymmetrical Kidney, 7½ Inches Long, Removed at Autopsy. Note the fissures and depressions. (Author's collection.)

Fig. 267.—Single Asymmetrical Kidney, Markedly Convoluted, Removed at Autopsy. (Author's collection.)

was 4 inches long, 2½ inches wide and 2 inches thick. Five or six irregular elevations could be seen on its surface.

The *microscopical report* of Dr. Noyes showed changes of chronic interstitial nephritis, with the production of a moderate amount of new connective tissue, degeneration of tubules in the cortex with exudates, glomeruli filled with leukocytes, proliferation of epithelia. The tubules in the medullary portion were more normal (Fig. 267).

ANOMALIES OF THE BLOOD VESSELS

Vascular anomalies may exist in cases of abnormal kidneys, but they may also be found in an otherwise perfectly normal gland. Some of these anomalies have a surgical interest, although most are mere anatomical curiosities.

The vessels may be abnormal by their origin, by their distribution or by their number. Anomalies of the renal artery are more important, and also more common than those of the vein.

The artery may originate much lower than usual; this is ordinarily coupled

with a congenital ectopy of the gland. Among the anomalies of distribution, the most interesting is the premature branching off from the trunk of the renal artery of the branch going to the lower pole of the kidney. This artery then crosses the ureter near its origin, and may become the cause of an hydronephrosis; in three cases out of four (English), it passes in front of the ureter, whereas in the fourth it passes behind. This artery is not a supernumerary vessel, as is sometimes stated; but it is a normal artery of the kidney, which cannot be ligated or cut without necrosis of the corresponding part of the gland.

The renal artery itself may be replaced by two, three or even four trunks.

There may also be renal supernumerary arteries that are small and may be severed without interfering with the nourishment of the kidney but may give rise to considerable hemorrhage during renal operations.

An embryologically interesting anomaly of the left renal vein is that in which, all other things being normal, the vessel ends abnormally low into the vena cava, at the level of the fourth lumbar vertebra, and receives perpendicularly the vena azygos minor.

CHAPTER XXI

KIDNEY INJURIES

Broadly speaking, there are two varieties of kidney wounds: First, those that are inflicted without the wall of the body having been opened or pierced; and second, injuries of the organ by some instrument, weapon or missile that has passed through the body wall. The former is called a *subparietal* (closed) injury, and is usually due to a direct blow, a fall, striking on the kidney region, or a crush from the wheel of a vehicle; the latter is called an *open* wound, and is due to a slash or a puncture with a knife, sword or bayonet, or to a projectile from a firearm.

Kidney injuries are rare, if surgical wounds are excluded. In 7,741 cases of injuries reported by Küster, but 10 were renal. Contusions are the most frequent, next come gunshot wounds and last incised and punctured wounds. I have had 5 cases of subparietal injury and 1 open wound (a stab).

There is an instinctive tendency to consider all injuries involving the kidney as dangerous. This idea has been inherited from surgeons who were not familiar with renal surgery, but at the present writing operative interference has shown us that this fear was not justified and that kidney wounds, like the wounds of all highly vascular organs, often heal quickly. Experimental surgery, in the hands of Albarran, Legueu, Paoli, Podvyssotsky, Tuffier and others, has taught us that the mechanism of wound repair in the kidney is essentially the same as in any other parenchymatous organ; that is, the proliferation of the interstitial connective tissue of the gland bridges the gap between the two edges and then permanently replaces this temporary mending in the natural way with the aid of a clot. The functionating elements of the gland degenerate and are replaced by connective tissue. Scar formation is rapid in the kidney and the process of repair has been shown far advanced after six days. The parenchyma is substituted by common scar tissue, which is slowly permeated by scant, newly formed capillaries. It has been claimed by several that, after the healing of a kidney injury, a regeneration of the epithelial cells and the glomeruli takes place. I do not believe, however, that such a process is possible, as in such a case the kidney parenchyma would have regenerative powers that are not shared by other tissues in the body. The epithelial cells of the kidney are so delicate, that even a temporary ligature of the renal vein is enough to alter them deeply;

and highly specialized cells do not regenerate. As for glomeruli, one does not understand how such a complex formation could regenerate, even in very young people. If the glomeruli appear more abundant near a renal scar, it is probably because of the shrinkage of the connective tissue in the vicinity.

There is undoubtedly a compensatory hypertrophy after any loss of substance of the kidney, but this is not due to the regeneration of renal elements. Compensation in the remaining kidney, after nephrectomy, for instance, is established not through formation of new elements, but through an increase in size and in functional activity of the surviving elements; for it must not be overlooked that we have normally in the body a much greater amount of kidney tissue than is necessary for the maintenance of life. Tuffier removed one kidney in dogs and had to slice off a large part of the other, before he obtained any symptoms of urinary insufficiency.

SUBPARIETAL INJURIES

Etiology.—Contusions of the kidney are seen a little more frequently on the right side than on the left (142 to 118). They sometimes have taken place in both sides; while cases are on record of the rupture of a single asymmetrical kidney, and one case of a ruptured horseshoe kidney. In my series, 3 cases were on the right side. The most susceptible age is from ten to thirty, that is, the age of greatest muscular activity and liability to accident. Men are much oftener affected than women. In my personal cases, eighty per cent occurred in men. Küster gives even as high as ninety-four per cent in men and six per cent in women.

The kidney may undergo rupture as a consequence of a *direct violence*, such as a blow, fall on the loin, kick from a horse; or of an *indirect compression* of the body between two surfaces, as in elevator-shaft accidents, by the pinning of the lumbar region between the buffers of railroad cars, or by the passage of a carriage wheel over the costo-iliac space, the body resting flat on the ground. The latter two accidents and a fall on the loin are the most common.

Some claim that a kidney may be ruptured by indirect violence, such as a strong muscular contraction when the body is bent suddenly forward or on one side; but personally I am inclined to doubt the possibility of a rupture of so well-protected and so movable an organ from a mere muscular contraction, unless the kidney is very much congested or distended on account of some obstruction to the urinary flow.

The theories of the mechanism of rupture do not account for all forms of renal injuries, but they are the best we have at our disposal at present.

Pathology.—The pathology of contusions depends on whether the fibrous capsule is torn through or not. If the capsule is not torn through, the hemorrhage is usually slight, in which case there is a *subcapsular* ecchymosis or hema-

toma, or irregularly shaped areas of hemorrhage within the parenchyma near the surface or extending as deep as the pelvis.

True rupture exists when the capsule is torn and the laceration is deep enough to communicate with the pelvis of the kidney. Fissures are usually found on the anterior aspect of the organ and are *transverse* in direction or radiate from the hilus. Infarcts of the usual wedge shape may follow contusions of the kidney. In cases of true rupture of the kidney, there is an extensive leakage of blood, or blood and urine, into the surrounding tissue, according to whether the excretory channels are torn or not. If the rupture is *very extensive,* the two halves of the kidney are held together by the pedicle only, or, *in extreme cases,* the kidney may be divided into a number of small pieces, some of which may be totally detached.

The perirenal extravasation may burrow down along the ureter and collect around the pelvic organs, but it usually collects in the retroperitoneal cellular tissue, where it forms a rapidly growing liquid tumor known as a pseudo-traumatic hydronephrosis. The contents of the tumor resulting from rupture of the kidney consist of a brown-red fluid, which it is said may later change to amber and resemble clear urine. Personally, I have never seen the clear fluid after a rupture of the kidney, and I have cut into these extravasations of very large size some time after the injury. Clear fluid I am inclined to regard as coming from a rupture of the renal pelvis or ureter.

Detachment of the kidney from its pedicle is very rare and is accompanied by severe, generally fatal, hemorrhage. When death does not occur at once, infarction and necrosis of the kidney (extravasation with gangrene of the perirenal tissues) are liable to follow.

Fracture of the ribs is a frequent complication of renal contusion. The peritoneum is torn in some cases of violent injury, an accident more apt to occur in children under ten years on account of the firm connection between the peritoneum and the kidney at this early age. Other abdominal organs may, of course, suffer coincidently with the crushed kidney.

Symptoms.—The Urine.—When a kidney is torn, even slightly, it bleeds more or less profusely. Hemorrhage is, therefore, the most important consideration in the symptomatology of renal contusions. Of all forms of bleeding, *hematuria* deserves the first place, because it is the most frequent and the most characteristic. It occurs in the great majority of cases, even in mild injuries, and is lacking only when there is a small tear that does not reach the calices, and when the continuity of the kidney with the ureter has been destroyed. It will thus be seen that it is not always an alarming symptom *per se*, and that its absence does not invariably indicate a mild injury. Hematuria, coming on after injury, does not mean necessarily a contusion of the kidney in the sense that we are considering; for if a calculus is present, the bleeding may have been provoked by the traumatism of the stone within

the kidney, as after a jar. Blood and urine pressing on the outside of the pelvis or ureter may prevent hematuria.

The hematuria after an injury to the kidney may be profuse at once, or slight and subsequently increase; or it may be intermittent. In addition to fresh blood, clots or casts of the ureter may be passed, or the blood clots may accumulate in the bladder and be discharged with difficulty. It lasts from two to eight days in the average cases. In some, it may continue remittently for weeks. In infected cases, secondary hemorrhage may occur.

Certain conditions that affect the character and amount of urine passed occur as the lesion begins to interfere with the function of the kidney. Oliguria and even anuria may result if a blood clot occludes the ureter. Later polyuria may occur, either simply compensatory in character or indicating the presence of a traumatic nephritis. Albumen and pus may also be found in the urine, indicating the presence of an infection and renal suppuration. Together with hemorrhage, we should look for the general symptoms such as accompany other abdominal injuries, and are summed up by the word "shock," symptoms which are due to injury to the solar plexus and other of the adjoining nerve plexuses as well as the loss of blood. They include pallor, cold extremities, cold perspiration, a small and rapid pulse, vomiting, vertigo and prostration. If internal hemorrhage be severe, there are added to this gradual blanching of the skin and mucosæ, a thready pulse, anxiety and collapse. If peritonitis comes on later, there are the usual general symptoms associated with this complication.

Local Symptoms.—The *local* symptoms generally come on at once after the injury, although they are sometimes delayed. They include pain of a varying character, usually not severe when due only to the injury of the external tissue or to fractured ribs. It may, however, be very severe, radiating like that of a renal colic, and increasing on movement and often upon respiration. Sometimes patients complain of a sensation of something bursting at the moment of injury.

Retraction of the cremaster and pain in the testis on the affected side, are regarded as signs of severe renal hemorrhage and of blocking of the ureters by blood clots (Le Dentu). There may also be muscular rigidity over the injured organ. The renal pain may last for weeks, and sensitiveness on pressure persist for a long time.

Physical Signs.—The skin about the injured loin may be ecchymosed or lacerated. Ecchymosis may also follow the connective-tissue sheaths of the spermatic vessels and thus reach the external abdominal rings. In certain cases, it has been seen to extend over the external genitals. A characteristic feature of these ecchymoses due to renal injuries is that they usually reach the inguinal ring late—two or three weeks, perhaps, after the accident (Sebilleau, Dumenil, Le Dentu)—but it must be remembered that they may also be due to injuries of other vessels in the retroperitoneal tissues.

The *swelling* may be very slight in mild injuries, but it is always distinct

in the more severe forms. It usually comes on suddenly in severe cases and depends upon the amount of the effusion of blood and urine. The tumor is usually palpable even in mild cases and is dull on percussion, when the swelling is sufficiently large to percuss well.

Complications.—The complications are aseptic or infectious in character. Aseptic complications are intraperitoneal hemorrhage, and, rarely, traumatic nephritis. Infectious complications are peritonitis, perinephritic abscess and pyelo-nephritis.

Peritoneal Complications.—Effusions of blood into the peritoneum occur when the injury includes a rent in that membrane, or when the liver, spleen, or some other organ is torn. A *septic peritonitis* develops within a short time when infected urine flows into the cavity along with the blood. However, this is fortunately not a common occurrence, as the peritoneum is fairly resistant to aseptic urine. According to experiments quoted by Wagner, such urine is borne by the peritoneum for forty-eight hours without much damage. Ascending and hematogenous infections may also attack the peritoneum in subcutaneous injuries of the kidneys (de Quervain).

De Quervain noted that, owing to disturbances in circulation of the colonic flexure on the affected side, a certain degree of meteorism was often present without any peritoneal involvement. This is a point worth remembering, as such tympanites are apt to mislead one into the diagnosis of traumatic peritonitis.

Chronic Traumatic Nephritis.—Chronic traumatic nephritis, as a complication of subcutaneous renal injuries, deserves a few additional words, as it has been the subject of considerable controversy. It is not certain whether a diffuse nephritis can follow such an injury, and it is probable that in the cases in which diffuse renal lesions were found at autopsy after contusions of the kidney, the patient had been suffering from chronic nephritis before the injury. Circumscribed nephritic lesions may occur, however, in the areas immediately involved. In such cases, which are rare, the albuminuria and the casts persist for some time in the urine after the hematuria disappears. Albumin has been found in small amounts for a year or more after the injury.

Diagnosis.—The diagnosis of a renal contusion is possible in a positive way when hematuria is present. All other symptoms may lead us to suspect such a lesion, but none is sufficiently characteristic This does not mean that they must not be looked for carefully. The existence of a perirenal hematoma, coupled with the history of the case, has, however, great value.

The differentiation between a subparietal renal injury and a renal colic due to calculus and preceded by an accidental traumatism, is not always easy. The history of the case and the repetition of the attacks at intervals may help in making this distinction in the limited time at our disposal in these cases. Renal tumors often give rise to pain and hematuria after an accidental blow,

and, in such cases, the diagnosis will have to be reserved until the urine and the cachexia give a clew to the condition.

We have seen that the severity of the symptoms is by no means a measure of the extent of the injury in subcutaneous renal traumatism. An exception to this, perhaps, is the rapidity with which the renal hematoma develops. This is usually proportionate to the severity of the injury.

In cases with slight or absent swelling and pain, but with persistent hematuria, the cystoscope will show from which side the bleeding comes. Muscular rigidity on the affected side is of service in doubtful cases.

In another class of cases, the bleeding continues slowly until a tumor resembling a small watermelon in shape and size develops on one side of the abdomen, most marked in front (Fig. 268). In this case, a lumbar incision should be made in the ileo-costal space behind and the contents evacuated. The amount of mixed urine and blood in such cases is often astounding.

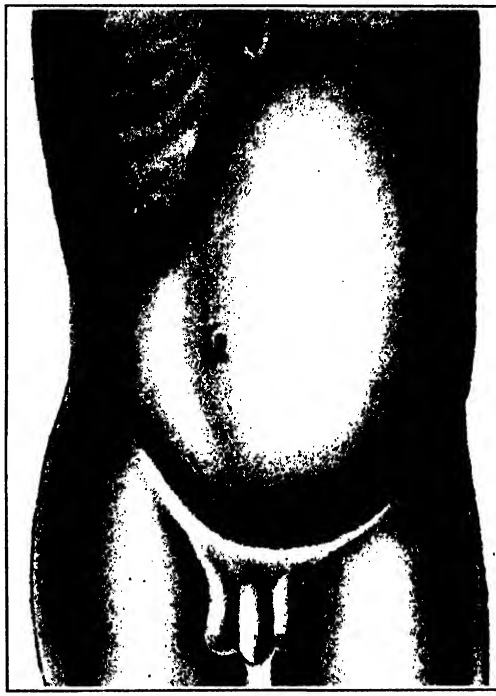


Fig. 268.—Shape of the Abdomen in the Case of a Ruptured Kidney. The rupture extended into the renal pelvis. There was a slow leakage of blood and urine. (Author's case.)

Prognosis.—The prognosis of renal contusions varies with the severity of the lesion. The chief danger is from complications, and recoveries are on record of patients who have been in an apparently hopeless condition. Death may occur within a short time as a result of collapse from hemorrhage. If the patient lingers on, complications may be feared. According to Morris, in rupture of the kidney, its pelvis, or ureter, the prognosis, as far as life is concerned, is less favorable than in rupture of other abdominal organs.

Statistics of mortality from subparietal renal injuries vary somewhat. Edler gives fifty per cent mortality, Küster forty-seven per cent, Keen thirty-three per cent, but Albarran thinks that these figures are exaggerated, as he saw seven cases without a death and as Le Dentu notes that recovery took place in nearly all cases observed by him. Guyon, at the Necker Hospital for the past ten years, does not record a single fatal case. The high mortality figures are due probably to the fact that only the grave cases are published. Hemorrhage

and suppuration are the most frequent causes of death. Wagner could find but three cases on record where the patient recovered from a renal contusion complicated by a demonstrable tear in the peritoneum. Küster considers these cases as offering the most unfavorable prognosis. The question of prognosis bears directly on the question of treatment.

Treatment.—In mild and moderately severe cases, renal contusion heals spontaneously, in which case there is no place for active surgical interference. In fact, such patients, when kept in bed, with strips of adhesive plaster across the back, recover quite well in a very large proportion of cases. The usefulness of ice bags is doubtful.

In complicated cases, rest in bed should be maintained for a week or longer, after the swelling and all traces of bleeding have disappeared. Shock should be treated in the usual way, but cases of rupture of the kidney must be very carefully watched and, if the shock is great, the pulse thready, indicating internal hemorrhage, rapidly increasing, an incision should be made and the wound in the kidney repaired by suture, if not too extensive. If, however, the kidney is badly lacerated, an immediate nephrectomy is indicated.

If the renal hemorrhage is found to be active, the kidney must be repaired or removed. In two such cases of my own, after evacuating the contents and packing the cavity, the hemorrhage ceased. Later I removed the kidney in one of these, on account of infection and the great damage done to the kidney.

Still another indication for operative intervention is given by the late infection and suppuration of a perirenal hematoma. This may require an operation three weeks after the accident. The kidney is sometimes necrotic and has to be removed.

To sum up in a few words: The immediate indication for operation is hemorrhage; the late indications are perirenal accumulations and infection.

The *results* of operative treatment as contrasted with the nonoperative treatment, are tabulated thus by Morris (vol. i, p. 198).

In twenty-six cases collected from English and American sources from 1884 to 1893 inclusive, he found:

One died of other causes.

Fourteen treated palliatively, ten died—70.7 per cent.

Eleven treated by operation, three died—27.2 per cent.

This is not absolutely convincing proof of the superiority of the operative method. My personal results to date are:

One treated palliatively, no death.

Four treated by operation, one death.

Illustrative Cases.—I will give a brief *résumé* of the five cases of subparietal injury of the kidney I have had.

Case I.—Case of subparietal subcapsular injury of the right kidney. The patient was a laborer, thirty-eight years of age, who one week before seeking

admission to the hospital had a fall, striking on the right side. This was followed by pain in the loin and inability to pass urine for twenty-four hours; when he finally passed urine, it was red in color.

Status præsens: A mass the size of a cocoanut, dull on percussion behind, is felt in the right lumbar region. Local pain and tenderness. No temperature.

Urine: Of a Burgundy-red color. Specific gravity, 1.022. Albumin, twenty-five per cent in bulk. Some leucocytes and abundant red corpuscles.

Treatment: Rest in bed; milk and Vichy diet; urotropin and Basham's mixture.

Course: The patient remained in the hospital five weeks. At the end of the first week, the urine was straw-colored, specific gravity 1.019, of acid reaction and contained a few blood cells and calcium oxalate crystals. By the end of the second week, three weeks after the accident, all traces of blood had disappeared from the urine, and the tumor was diminishing in size. It could scarcely be felt at the time of discharge, five weeks later.

CASE II.—The patient, a laborer, twenty-two years of age, eleven days before admission fell while dumping a box of dirt, and struck the ground on the left side from a distance of twenty-five feet. He was unable to walk and had to be carried home. A few days later, the painful swelling, that had been gradually increasing in size, occupied the entire left side of the abdomen. The general symptoms increased in severity, and the patient entered the hospital.

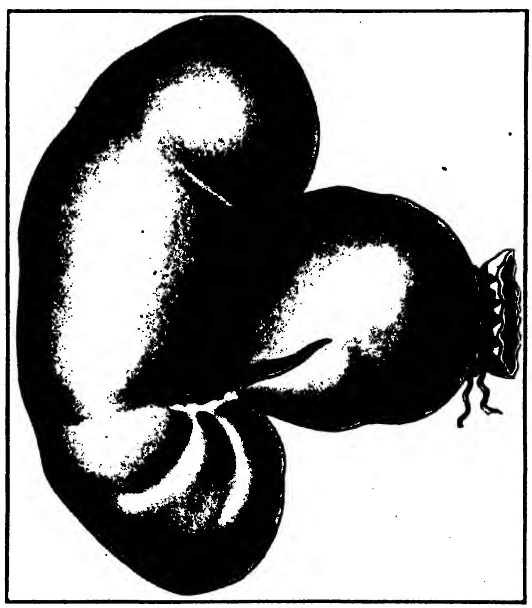


FIG. 269.—RUPTURE OF KIDNEY. Shows the rent in the kidney proper and pelvis of a ruptured kidney. The kidney is turned so as to show the tear. (Author's case.)

Status præsens: There was a swelling in the left side, resembling a small watermelon in form, dull on percussion (Fig. 268). Temperature 101° to 106° F.; pulse, 88; respiration, 20. There was no visible hematuria. The local findings led to the diagnosis of splenic rupture.

Treatment: Operative. An incision was made in front, along the outer border of the rectus muscle, and the peritoneal cavity was opened. The gut was found stretched between the anterior and posterior peritoneal walls like pieces of ribbon, due to a retroperitoneal tumor that was pushing forward the abdominal contents. The patient was accordingly turned and an incision made in

the loin behind, when two and one half gallons of a reddish-brown bloody fluid escaped. The kidney was found ruptured posteriorly, showing a transverse rent in the kidney proper extending into the pelvis that admitted three fingers. The opening was just above and posterior to the ureter. The organ was surrounded by a dense mass of tissue and very adherent to the adjacent parts. The wound was packed and drained, but a week later the drainage became impaired, and there was much pain and distress. Reopening of wound and removal of two and one half quarts of a brownish fluid containing pus. Nephrectomy one month later. The patient recovered (Fig. 269).

Case III.—The patient was a grocer, thirty-one years of age, who three weeks previously, following a fall, began to suffer from pain, gradually increasing, and swelling in the left lumbar region, with anorexia and constant thirst. No irregularities of urination. No visible hematuria.

Status præsens: A large tumor, not sharply defined, also shaped like a melon, was felt in the left lumbar region. Temperature, 102° to 103° F.; pulse, 98.

Treatment: Operative. A lumbar incision was made, and a large amount of a brownish fluid like broken-down kidney tissue was removed. The cavity was packed with gauze. Suppuration followed, and the patient remained in the hospital for two months, when he was discharged with the wound in the kidney healed.

Case IV.—The patient, a housewife, thirty-six years of age, had complained for eight years of occasional pain in the right lumbar region, with fever, lasting from a few hours to days. For some time before coming under treatment, she had noticed an increasing fullness in the lumbar region. Examination showed a well-defined tumor on the right side, extending from the costal margin to the iliac fossa, beyond the umbilicus. There was another bulging in the ileo-costal space behind. At this time the patient's temperature was 101° F.; pulse, 94; respiration, 36. She was sent to the hospital in an ambulance, and at the time of admission, a few hours after the first examination, her temperature was 105° to 106° F.; pulse, 130; respiration, 46. No well-defined tumor could be outlined in the examination, but there was a general mass over the entire right side of the abdomen. It was evident that the ride in the ambulance had caused rupture of the kidney and leakage into the postrenal space. An incision was made the next day, and a large amount of blood and pus evacuated. The temperature dropped at first, but then ran a septic course due to imperfect drainage. The kidney on removal was found to contain a stone. The outcome was death.

Case V.—The patient was a man twenty-nine years of age, an ironworker by occupation, who gave a history of many attacks of malaria. Two years ago he had pain in the right loin, lasting four or five days, and this had recurred since at intervals of four or five months, with a little fever, lasting for hours

or days. Four months before coming under treatment, the patient, while lifting a piece of metal, heard something snap on the right side; this was followed by faintness and cold perspiration. There was a strong desire to urinate, and the urine passed was bloody, remaining turbid ever since that time. At the time of admission, the patient had a septic temperature, averaging 100° F.; his general condition was bad. A large mass could be felt in the right side.

Treatment: Operative. An incision was made in the loin, and three pints of mixed urine, blood and pus were evacuated. A ragged opening was found in the lower pole from which protruded a fragment of stone, over an inch in length and one third of an inch in width. The wound was packed. The temperature dropped after the operation; the wound did not heal and a sinus remained, discharging urine and pus. Nephrotomy was performed, followed by free drainage of the kidney, and the patient left the hospital one month later in good condition.

INCISED, PUNCTURED AND GUNSHOT WOUNDS OF THE KIDNEY

Etiology.—Incised and punctured wounds of the kidney are almost always due to a thrust, or to a fall on something sharp, as a pointed weapon. The kidney is generally alone affected, as the wound is usually due to the stab of a knife in the back or side, and the opening of the peritoneal cavity is infrequent. Still rarer is a complete division of the organ. When the kidney wound results from a thrust through the anterior wall of the abdomen, the other abdominal organs are usually injured as well.

The wound may vary considerably in depth and direction. As these wounds are often inflicted by septic instruments, it is not surprising that they frequently become septic.

Gunshot wounds are rarely seen in civil practice, and in war they are almost always complicated with gunshot injuries of other organs on account of the high velocity of modern firearms. Edler states that these wounds constitute about one twelfth of one per cent of all gunshot injuries. Only three cases are on record in women.

Pathology.—The bullet may remain in the kidney and become encysted there, or it may pass through the organ, or it may graze it and cut off a piece of renal substance, or pass through the renal pelvis. Fragments of cloth, bone, etc., may be carried with the bullet and remain in the track of the projectile. There is always a certain amount of contusion along this tract, and an eschar forms in its walls. The kidney may, however, be mashed to a pulp by the projectile. The orifices of entrance and exit are of unequal size, the latter being usually the larger. Stellate fissures radiate from these openings when the kidney is flaccid, or a long and wide fissure results when it is distended at

the time of the injury. Unless the pyramids or calices be wounded, no blood escapes and there is but little hematuria at first in the average case, though blood may accumulate in the perineal space.

These wounds heal by granulation followed by the formation of cicatricial tissue, after the slough has separated from the tissues and has been discharged.

Foreign bodies carried in with the bullet may become encysted in the kidney, or pass into the ureter or through the external wound. Fistulæ are frequent sequelæ.

Symptoms.—They are the same as those of contusion; namely, hemorrhage and shock and a wound in the lower region or in the abdomen below the costal arch. Pain in the wound, radiating along the ureter, is a very variable feature. The hemorrhage may take place externally, internally, or through the ureter.

External hemorrhage alone is exceptional. It is generally associated with hematuria. The latter is rarely absent and may be an early sign. The amount of hematuria is much greater in proportion to the internal perirenal as well as the external hemorrhage. When the outer wound is large, there is considerable external bleeding and generally very little lumbar swelling. If the calices or pelvis are wounded, urine will be mixed with the blood. In gunshot wounds, the immediate hemorrhage may be slight, owing to the presence of a clot, but when a slough separates, after five or six days, there may be a profuse secondary hemorrhage. Prolapse of the kidney through the wound is extremely rare. The symptoms of renal injury may be obscured by those of the other abdominal organs simultaneously involved. Retention of urine in the kidney may be caused by a clot clogging the ureter. The complications are all referable to infection and consist in peritonitis, nephritis, pyelitis and perinephritic abscess.

Diagnosis and Prognosis.—The situation, direction and origin of the wound, hematuria, hemorrhage from the external wound, or ordinary extravasation, are the chief guides in the diagnosis. In case there is an escape of urine from the wound, the odor of the fluid is usually strong enough to prevent errors; but, if there is any doubt, an examination as to the presence of urea can be made. A digital examination of the wound should be resorted to in doubtful cases. Lumbar pain and hematuria are reliable signs of a renal wound in these cases. The sounding of gunshot wounds is only permissible under circumstances pointing to the presence of a foreign body. The X-ray will often locate the bullet.

The prognosis is always grave and depends largely upon coincident infection, upon peritoneal penetration and upon the participation of the renal pelvis and renal vessels in the injury. Albarran gives the general mortality as fifteen per cent. Of forty-three cases of punctured and incised wounds of the kidney collected by Küster, ten (twenty-three per cent) ended fatally. The death

rate has been considerably lessened by operative treatment. Experience in the South African War, according to Morris (vol. i, p. 233) showed that penetrating wounds of the kidney, caused by modern small-bore bullets, do not necessarily have a fatal issue, even when other organs are traversed, and that the kidney or the liver may be pierced from before backward or from side to side, without any symptoms of importance following. These fortunate cases are due to the fact that small-bore bullets do not lacerate and make very small wounds—a fact that has altered many aspects of military surgery within recent years.

Treatment.—The general treatment is that of shock and hemorrhage, consisting in stimulation for the former, and a hot saline enema or intravenous injection for the latter. A simple antiseptic bandage should be placed over the wound, and, if the patient's general condition improves, the treatment should be expectant and symptomatic. I do not believe in closing the wound, although, if it is very large, the edges can be brought together by surgical plaster, allowing sufficient space for the escape of blood and bloody urine.

If the hemorrhage is severe, and the patient does not rally under stimulants, the case becomes an emergency one, and a wide lumbar incision must be made, the kidney reached and sutured, leaving a drain from the surface of the kidney to the outer dressings. If the organ be found too extensively involved, a quick nephrectomy should be performed.

To sum up: Put on an antiseptic bandage with an ice bag over the wound, counteract shock, check the hemorrhage, keep the patient quiet and *be as conservative as possible.* Such are the guiding rules for the treatment of all kidney wounds.

Illustrative Case.—I have had only one case of punctured wound of the kidney, a laundryman, twenty years of age, who was stabbed in the loin from behind just above the twelfth rib, and was able to walk to the hospital.

Status præsens: There was a wound, about three quarters of an inch in length, in the lumbar region, and a mass was present resembling an enlarged kidney. The patient vomited and complained of pain in the loin. His pulse and temperature were normal.

Treatment: Internally, 15 minims of the fluid extract of ergot given every three hours, and urotropin given every six hours. Wet dressings on the loin.

Course: On the following day, he urinated a quart of red blood and continued to pass bloody urine for seven days, when it became clear and he left the hospital. Two days later he began to suffer from frequency of urination, voiding every three hours, and on the following day again passed red urine. There was severe pain over the pubic region, and the patient reëntered the hospital,

where he was catheterized and a quart of bloody urine was drawn off. At no time did he have any fever. The hematuria ceased altogether at the end of two weeks after the accident, when he left the hospital. The renal hematoma in the loin persisted during the whole time, and was still present on the right side at the time of the discharge.

CHAPTER XXII

MOVABLE KIDNEY

MOVABLE kidney is frequently referred to as floating kidney, but more correctly speaking a movable kidney is one that has an abnormal range behind the peritoneum in a vertical plane, while a floating kidney is one with a mesonephron which floats among the abdominal viscera.

The kidney is held in place by the fatty capsule which surrounds it, the perirenal fascia, the suprarenal capsule to which it is adherent, the renal pedicle, and through the intra-abdominal pressure. The perirenal fascia (see Fig. 30) incloses it on all sides, but is open at the lower inner part, in which direction the kidney tends to move. There is normally some mobility of the kidney, from 3 to 5 cm., greater in women than in men, depending upon the length of the vascular pedicle. It may be said that, whenever a kidney can be felt projecting below the ribs, moving on respiration and sensitive to the touch, it may be considered movable in the pathological sense. The frequency in autopsy findings differs greatly from the clinical statistics. For instance, Epstein, in compiling postmortem statistics, found that it had occurred once in 500 cases and Newman estimated 1 to 1,000; while, clinically, Kutnow found it in 20 per cent, Glénard in 22 per cent, Goddard-Danhieux in 35 per cent of women and 21.35 per cent in men, and Harris in over 50 per cent in women, while in men it was present in 2.3 per cent. I believe it is safe to say that it occurs in 10 per cent of women, although I think the percentage of those who suffer to any marked degree from the mobility is much less.

Three degrees of movable kidney are spoken of: First, when the lower half of the kidney is palpable (Fig. 270, I); second, when the entire organ is palpable (Fig. 270, II); third, when the entire organ can both be palpated and is freely movable downward and inward (Fig. 270, III). The third degree, according to Glénard, constitutes a floating kidney. The organ is at times even more movable and has been found in the female pelvis, from which position it has been removed by operators who mistook it for a cystic ovary. When it moves away from the loin, its usual rotation is downward and inward, and, as it progresses, its lower pole moves forward and its upper pole tends to point backward. (See Fig. 270, III). It sometimes pulls on the duodenum and often makes an

extensive excursion with the ascending and hepatic flexure of the colon, especially when there are adhesions to one or the other of these viscera.

In mild degrees of movable kidney, the ureter gives rise to no trouble; but when the displacement is marked, it may curve or kink, although still allowing the urine to pass through it, but less easily than under normal conditions. This

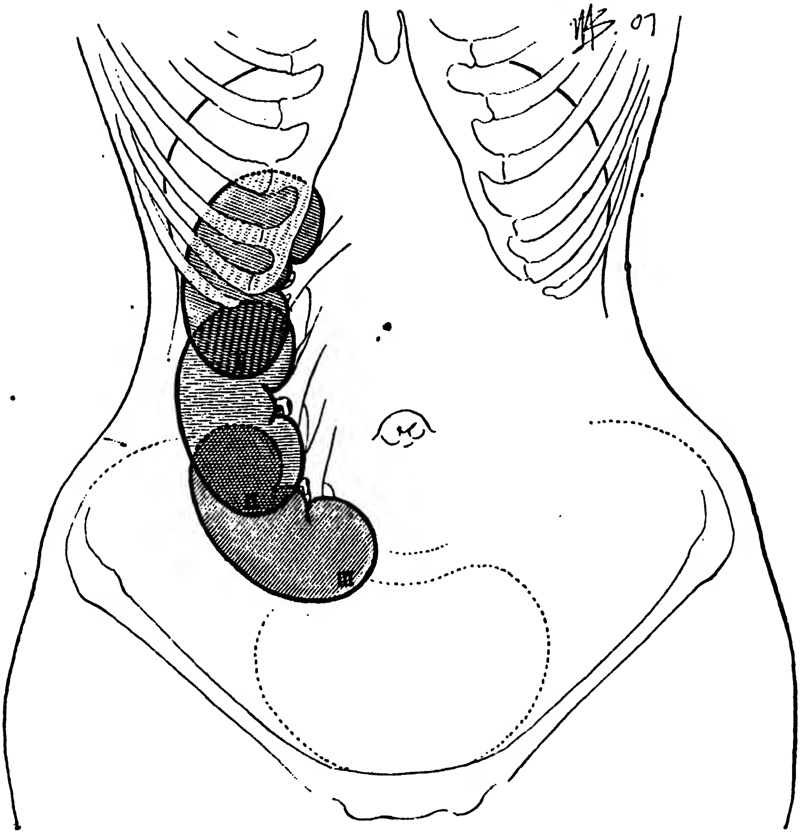


FIG. 270.—DISPLACEMENT OF THE KIDNEY, SHOWING (I, II, III) THE FIRST, SECOND AND THIRD DEGREES OF DISPLACEMENT. (Kelly's "Medical Gynecology.")

may interrupt temporarily the flow of urine (Fig. 271). When the kinks are held by adhesions, the course of the urine may be seriously impeded, giving rise to retention of urine in the renal pelvis and attacks of pain.

The suprarenal capsule does not move with the kidney. The peritoneum over the kidney may become loosened and elongated and accompany it in its excursion, resembling a mesonephron.

Etiology.—The etiology of movable kidney is still a subject for discussion. Women are predisposed to this condition. The relative frequency in men and women is variously estimated from 1 in 7 to 1 in 15. In my practice it is 1 to 5, but presumably because my male patients are more numerous. The reason

for this predisposition in women is that the renal fossa, i. e., the hollow in the loin where the kidney rests, is shallower in the female. It is also more open below and narrower at the upper part, whereas in men the fossa is deeper and narrower at the lower part.

The most favorable period for the development of this condition is that of gestation, although it is frequently found in young girls and has been reported in infants. The right side is affected in between 85 and 90 per cent of the cases on account of the longer pedicle, the pressure transmitted to the kidney by the liver during respiration, and pressure from corsets, waistbands, belts and girdles.

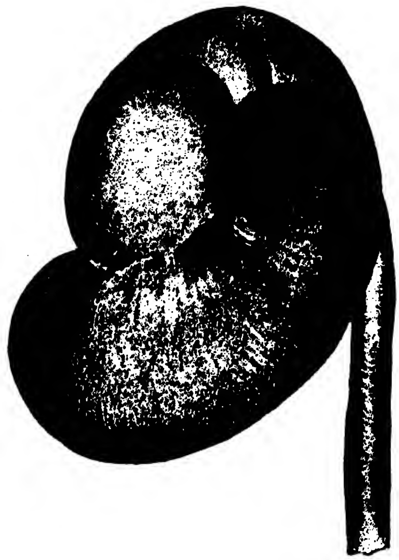


Fig. 271.—Kinking of the Ureter in Displacement of the Kidney This kinking of the ureter may interrupt temporarily the flow of urine, leading to the formation of an intermittent nephrydrosis (hydronephrosis). (Harris, in Reed's "Textbook of Gynecology.")

Pregnancy is considered an important cause, especially when frequently repeated at short intervals and followed too soon by exertion. Multiparæ are affected more frequently than nulliparæ, in a proportion variously estimated at from 20 to 1, to from 5 to 1. This tends to show the importance of intra-abdominal pressure in the support of the kidneys and the fact that the abdominal wall, if its muscles are strong and well developed, serves as a bandage with the intestine acting as an elastic pad. It also emphasizes the importance of preserving the strength of the abdominal wall. In cases where this is much weakened after pregnancy, the woman should remain in bed until it has become stronger and, when she resumes her usual household duties, an abdominal support or belt should be worn.

A loss of fat is usually spoken of as an important cause, but this is not especially noted in the fatty capsule at the time of operation in thin subjects.

The question as to the connection of nephroptosis with general enteroptosis has been discussed by many and, according to Glénard, it is but a part of enteroptosis, the latter being a disease of general bad nutrition, accompanied by the falling forward and downward of all the abdominal viscera. Glénard's views, however, are not universally accepted and I think it is safe to say that while nephroptosis has no tendency to produce general enteroptosis, that the latter condition may assist in producing the former.

All observers seem to agree that the corset and the tight waistbands of heavy skirts in women, and the tight belts supporting the trousers in workingmen, are common causes of this condition. Corsets and waistbands supporting heavy clothing do evidently have a traumatic influence on the kidney, as the former

in many movements tend to push the liver against the kidney; whereas, if the kidney is displaced and it is pressed upon by a thin belt or waistband, the weight of the clothes tend to drag the kidney down during certain movements, as when the patient bends forward in the act of scrubbing, washing, or in other motions of a similar nature. The lifting of heavy weights, reaching for high objects, straining at stool, chronic hacking cough, horseback riding and the skipping rope also tend gradually to displace the kidney. These can all be spoken of as repeated traumatisms of a mild character.

I feel that the claims that sudden traumatism causes movable kidney—such as a blow in the loins, a fall upon the knees, buttocks or perineum, a blow on the thorax, a sudden muscular strain due to the abrupt stopping of a car and other claims of a similar nature which are used in suing corporations and railway companies—are groundless. In all such cases, if the traumatism had been sufficient to displace the kidney suddenly, it would have been grave enough to have ruptured the vessels or the renal pedicle and given rise to a dangerous hemorrhage, and, perhaps, sudden death. It is really the repeated traumatism of a mild character that causes the trouble, as has already been mentioned under corset and belt pressure. I believe that persons who suddenly complain of pain in the loin after a shock, a car accident or jar, and in whom a movable kidney is found on examination, would have shown the presence of such a condition had they been examined before the accident; but as there was no reason for such an examination, the presence of movable kidney naturally was not known. On the other hand, when a movable kidney exists, a sudden jar or wrench may give rise to renal strangulation and thus bring on symptoms that might induce one to believe that the mobility had been caused by the recent traumatism.

Heredity is spoken of as a predisposing cause of abnormal renal mobility. This may be true in a way, on account of the liability of the child to have the same body configuration as the mother, and, consequently, if the mother had a movable kidney, the child would be predisposed to its development, for I consider the body form as the principal predisposing factor in this condition and all others as slowly contributing causes.

The Body Index in Patients with Movable Kidney.—Becher and Lennhof, in examining a large number of women, found that they could generally judge from the appearance of the patient's figure whether one of the kidneys was palpable or not. After reasoning out the whys and wherefores of this decision, they made the following scientific observation and deduction: First, that more movable kidneys were found in women with a long distance from the suprasternal notch to the pubes and a small waist than in women with a short trunk and large waist; second, they decided, after taking many careful measurements, that the distance from the suprasternal notch to the upper margin of the symphysis pubes, divided by the smallest circumference of the abdomen and multiplied by 100, constitutes a body index. Given as a result

or quotient 75, representing the normal woman, if a number above this resulted, say 77 to 80, it could be considered positive that one kidney was movable; whereas, if it was below 75, say 73 or less, no movable kidney was present. The measurements were computed according to the metric system in centimeters.

$$\text{The mathematical index} = \frac{\text{Jugulo-pubic distance}}{\text{Circumference of abdomen}} \times 100 = \begin{cases} \text{75—normal} \\ \text{77-plus—positive} \\ \text{73-minus—negative} \end{cases}$$

Harris, of Chicago, continued the studies of Becher and Lennhof, but went into the subject more carefully, and has, therefore, been able to give to the profession a clearer and more comprehensive idea of the importance of the body form in movable kidney, as well as to depict the shape of the individual predisposed to movable kidney, in contradistinction to one who is not so predisposed.

Harris divides the body into three zones—the upper, middle and lower—by drawing three planes through the body transversely. (See Fig. 272.) He takes the tips of the tenth ribs as the landmarks, because they are fixed points, whereas the smallest circumference of the body is rather an uncertain location. He then proceeds to take certain measurements with the patient lying flat on the back. The circumference of the body at the tips of the tenth ribs is first measured and a mark is made with a pencil where this line crosses the median line. A mark is also made at the lower end of the sternum and the circumference is taken at this point also. The breasts must be drawn up, if they are in the way, and the circumference should be taken at the end of the ordinary respiration. Finally the distance between the upper sternal notch and the upper margin of the symphysis is taken, and a line drawn between these two points, upon which the length of each zone is noted. These measurements give us Harris's Index No. 1, which is simply the jugulo-symphysis, divided by the circumference at the tenth rib and multiplied by 100. It is similar to that of Becher and Lennhof, but it is more accurate. When this index is above 77 or 78, the kidney is palpable; but when it is below these figures, palpation is negative.

By a comparison of the different zones in cases with palpable kidneys, it was found that the increased length of the jugulo-symphysis was situated chiefly in the middle zone, while the upper and lower zones remained practically the same. In negative cases, the average circumference of the upper end of the middle zone was 77.1 cm., and of the lower end of the middle zone, 69.5 cm. On the other hand, in positive cases, the upper circumference of the middle zone was 73.46 cm., and 61.9 cm. for the lower circumference. Thus, there was a marked contrast between the positive and negative cases in regard to the circumference of the lower end of the middle zone. In other words, the middle zone was elongated and made narrower, especially at the lower end, whenever the kidney was palpable.

Harris found that there were still certain sources of error in this method of measurement. In taking circumferences, accurate measurements are difficult to get in fat subjects, for the breasts are in the way, though pulled up, and there is a certain spreading that corresponds to the lower margins of the ribs when a corpulent woman lies on her back. For this reason, he deter-

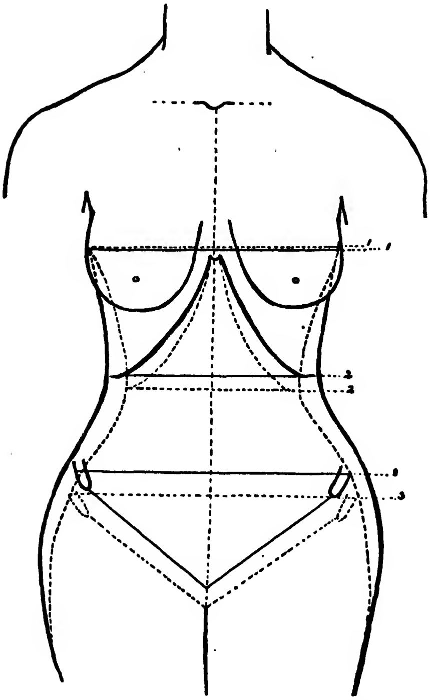


FIG. 272.—ANTERIOR VIEW OF THE BODY DIVIDED INTO THREE ZONES, THE UPPER, MIDDLE AND LOWER, MADE BY DRAWING THREE PLANES THROUGH THE BODY TRANSVERSELY. The normal female body is drawn in heavy black lines. The imperfect female body is drawn in dotted lines and is the one predisposing to movable kidney. These outline drawings show the lateral diameters of the body index in the healthy person and in people with movable kidney, as determined by Harris.

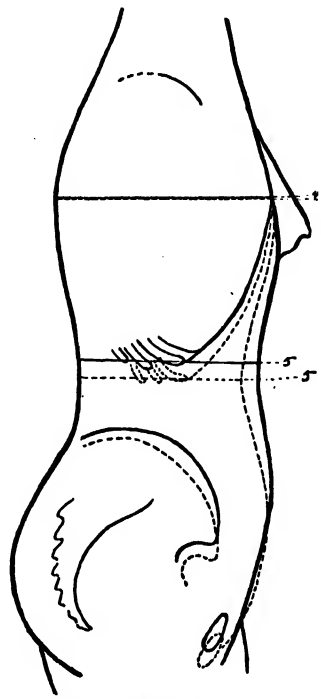


FIG. 273.—SIDE VIEW OF THE BODY AND THE LINES CORRESPONDING TO THE ANTERO-POSTERIOR DIAMETERS OF THE BODY INDEX AS DETERMINED BY HARRIS. Here, also, the heavy black lines show the normal person and the dotted lines the one predisposing to movable kidney.

mined to use calipers and measure diameters instead of circumferences, and have the patients standing during the measurements instead of lying down. In this way, he measured five diameters, which gave him very accurately the body form of the patient.

First Diameter: The widest or upper lateral diameter. This is taken with the calipers resting at the widest point of a plane corresponding to the lower end of the sternum, usually on the seventh ribs (Fig. 272, No. 1).

Second Diameter: The middle lateral diameter. This is the greatest distance between the lower edges of the tenth ribs (Fig. 272, No. 2).

Third Diameter: The lower lateral diameter—the widest distance between the iliac crests (Fig. 272, No. 3).

Fourth Diameter: The upper antero-posterior diameter; from the lower end of the sternum to the spinous process opposite in the same plane as the upper lateral diameter (Fig. 273, No. 4).

Fifth Diameter: The middle antero-posterior diameter; from the median line in front to the spinous process opposite on the same plane as the middle lateral diameter (Fig. 273, No. 5).

In order to draw conclusions from his transverse diameters, he divided the middle lateral by the upper lateral diameter and multiplied the quotient by 100, thus obtaining Index No. 2. The second index refers entirely to the middle zone and shows the relation between the lateral diameters of its lower and upper ends, or, in other words, the amount of constriction at the lower end.

Index No. 2 arranged as a mathematical problem is solved as follows and shows one of many results that may be obtained:

$$\frac{\text{Middle lateral diameter}}{\text{Upper lateral diameter}} \times 100 = \begin{cases} 73.23\text{—positive} \\ 85.26\text{—negative} \end{cases}$$

Furthermore, all cases below 81.8 were found positive, that is, with movable kidney, while all cases above 81.8 were found negative.

In detail, the measurements of the diameters were as follows:

	In Negative Cases.	In Positive Cases	Difference.
Average upper lateral diameter.....	23.62 cm.	23.85 cm.	0.23 cm. Practically same.
Average middle lateral diameter....	20.2 "	17.44 "	2.76 cm. or 13.6 per cent.
Average lower lateral diameter.....	28.7 "	29.06 "	0.36 cm. Practically same.
Average upper antero-post. diameter	16.9 "	17.03 "	0.13 cm.
Average middle antero-post. diameter	15.67 "	14.26 "	1.41 cm. or 9 per cent.

The difference between the upper lateral and the middle lateral diameters, in negative cases, was 3.4 cm. or 14.4 per cent, and the difference between the upper and middle antero-posterior diameters in these cases was 1.23 cm. or 7.28 per cent. In the positive cases, the difference between the upper and middle lateral diameters was 6.41 cm. or 27 per cent, while between the upper and middle antero-posterior diameters the difference in these cases was 2.8 cm. or 17 per cent.

These figures show that the middle zone diminishes in size from above downward nearly 100 per cent more from side to side, and 140 per cent more from before backward, in the positive cases than in the negative. This means that there is a marked diminution in the capacity of the middle zone in the positive cases in which the kidney can be felt and this diminution grows more marked in these cases as we advance in the middle zone from above downward.

As the upper zone remains practically the same in the two classes of cases, any lessening in the capacity of the middle zone must result in a crowding of the contents of this space downward—in other words, a greater tendency to

a displaced kidney. The above description contains the essence of Harris's views and is practically his own wording with his conclusions from the study of the body indexes as devised by him.

The two figures, one of the normal body and the other of the form predisposing to movable kidney, were drawn by Harris and presented to me by him. I here take this opportunity to state that, in my opinion, the careful study that Harris has made of cases of movable kidney has done more to make clear the predisposing cause of this disease than any other writings on the subject.

Symptoms.—In many instances there are no symptoms in a case of movable kidney, as has been ascertained frequently, when its presence was accidentally discovered during a physical examination for some other reason than for indications of movable kidney. Frequently the severity of the symptoms is by no means dependent upon the degree of mobility of the organ, as a slightly movable kidney may cause great suffering, while another may be markedly movable without giving rise to any signs.

Clinically, there are three types of movable kidney—first, the painful or neuralgic; second, the neurasthenic; third, the dyspeptic—according to the predominant symptom, although they may be associated in different degrees. Pain was present in 99 per cent of the cases in my own practice.

Pain.—Pain is due to traction on the nerve plexuses and on the peritoneum or other organs covered by the peritoneum, especially if adhesions are present. Its character is generally a dull ache, either constant or recurring, and accompanied by a sense of dragging or heaviness. It is usually situated in the loin below the twelfth rib and less frequently in front on one side of the umbilicus, in the iliac fossa or in the groin.

Occasionally there are acute, paroxysmal attacks of pain that come on suddenly, starting in the loin and radiating along the ureter, called Dietl's crisis, somewhat similar in character to those of renal calculus. During the severe attacks, there may be muscular rigidity on the affected side, the kidney may be found enlarged and tender from acute congestion, and the urine may contain blood. There may be oliguria at times followed by polyuria. These attacks usually last for a few hours and sometimes for a few days. They are due to kinks or compression of the ureter, causing an increased renal tension and resulting in variable degrees of renal retention or temporary hydronephrosis (Fig. 271). The records of my own cases show that of those having pain fourteen per cent had attacks occurring from every few days to every few months. The history of the attacks of pain covered a period of from four months to fourteen years.

In three per cent of my cases, the pain began suddenly and the patients attributed the condition to some movement they had made just before they first noticed the pain. In one case, the patient stooped over to pick up some clothes, since when she has experienced a peculiar sensation in her right loin

and has had occasional pain of a dull dragging character. Another woman first felt the pain come on while raising an awning, since when she has had it whenever she does hard work. Of course, the occurrence of the first pain coming on suddenly during some particular exertion does not mean that this has caused the trouble, but that the stage of mobility had been reached when any movement or jar might favor the sudden falling of the kidney or a ureteral kinking, causing a sudden pull on the renal or ovarian plexuses.

Attacks of pain generally increase in frequency, and sometimes in severity, as the case progresses. In twenty per cent of my cases, the pains were dull in character. The abdomen was usually relaxed.

Nervous Symptoms.—The nervous phenomena of movable kidney are spoken of as hysterical and neurasthenic. Among these nervous symptoms, which differ in various individuals, are irritability, restlessness, depression, languor, palpitation, vertigo, a feeling of pressure in the head, neuralgia, loss of flesh and appetite, and a general impairment of health. The nervous pains are generally nephralgic, sciatic, lumbar or intestinal, and sometimes ovarian or testicular.

Gastro-intestinal or Dyspeptic Symptoms.—Symptoms of this character are frequent. Of these, indigestion and flatulency are most common. Next in order are constipation, due to pressure or dragging upon the colon, gastralgia, nausea, vomiting and other symptoms of gastritis during attacks of renal strangulation. Jaundice from duodenal traction or compression of the bile ducts, or tugging on the hepatico-duodenal ligaments, is not so common as often assumed. Symptoms of appendicitis may be produced as the result of compression of the superior mesenteric vessels, and the congestion of the vermiform appendix which follows. According to Edebohls, this tendency to appendicitis is found in fifty per cent of women suffering from a movable kidney.

Among other symptoms, are weakness, dizziness, loss of appetite, throbbing in the abdomen on the affected side, headache and constipation. Chills and fever have occurred in a few cases, associated with pyelitis and renal retention.

Character of Urination and the Urine.—In discussing these two symptoms, there are several points to be considered. The character of the urination does not differ much from normal, any deviation depending principally on the presence or absence of renal retention or strangulation, the latter of which is not common. If there is renal retention, a temporary hydronephrosis, there will be a diminished amount of urine passed, or oliguria, while the secretion is retained in the kidney; but when the kidney returns to its proper position, a larger amount of urine will be voided, which is spoken of as polyuria.

In renal strangulation, there is a diminished amount of urine during the attack, after which an increased amount of a highly colored urine, often containing blood, is passed.

In the usual case of movable kidney, the urinary findings are slight, if any: a low specific gravity, a very slight trace of albumin and an occasional hyaline cast, or sometimes a few finely granular casts. These findings are due to the irritability of the kidney and the strain on both organs incident to the irregularities of the renal circulation and the urinary excretion.

Edebohls, in operating on movable kidneys by partially decapsulating the organs and fastening them to the abdominal wall, noticed, in cases with this variety of urine which closely resembled that of interstitial nephritis, that the polyuria, casts and albumen gradually disappeared or diminished. He, therefore, reasoned that, if people with movable kidney passed the same urine as patients with interstitial nephritis, movable kidney was the cause of interstitial nephritis; and furthermore, if the interstitial nephritis associated with movable kidney was cured by partial decapsulation, then any case of chronic nephritis could be cured by decapsulation, as it gave the kidneys a chance to form a collateral circulation with the abdominal wall or with the fatty capsule. This was the line of reasoning that led him to recommend total decapsulation of the kidney as an operation for the cure of chronic Bright's disease.

Physical Examination.—Very few practitioners can feel a movable kidney unless the mobility is quite marked, as they have not sufficient practice in renal palpation. This should not, however, be considered a reflection on their diagnostic ability, as I have seen the best surgeons and internists fail to detect this condition when kidneys were movable in a marked degree. Again, I myself have sometimes had the greatest difficulty in locating movable kidneys, the movement of which the patient could sometimes feel in her abdomen. Such difficulties occurred principally in patients with a large abdomen, either from distention or from thick walls. This leads me to state that the principal difficulties in detecting a movable kidney are, a thick abdominal wall, too firm pressure on the part of the examiner, and an unfavorable position on the part of the patient.

To show the ease with which one can detect a movable kidney at times, I will relate the history of a patient whose husband said she was suffering from indigestion and hives, and that she at that time had an attack of hives on her abdomen which annoyed her considerably and for which condition he asked me to prescribe. At the time of the visit, she was examined standing, with her skirts lowered and her upper garments raised in such a way as to expose her abdomen, which was the principal seat of the eruption. I at once saw a typical band of herpes zoster on her right side and, moving my finger lightly across it to see if the characteristic vesicular feel was present, I detected a kidney beneath my finger tips which was displaced by the gentle pressure used and which came back against them again when the pressure was removed. Since then I have seen several movable kidneys which have been as easily demonstrated, and none of which I would have been able to detect if I had resorted to the strong pressure that I was formerly in the habit of using.

A change of position is also a most important procedure. Most patients are examined lying flat on their backs with the result that, unless the kidney is held down by adhesions, it will go back into its fossa; and as this fossa, in the right loin, has in front and on its side the liver and ribs, it is extremely difficult to palpate the organ. It is, therefore, advisable to examine the patient on a table, the back and shoulder part of which can be raised so as to allow the kidney to fall from its lodgment, if it has sufficient mobility; then, having made firm pressure below the lower ribs behind and in front on that side, to prevent the kidney from slipping up, the patient should be lowered into the dorsal position again while keeping her abdominal muscles lax, so as to allow the examiner to maintain his grasp on the deeper tissues below the free border of the ribs.

If a movable kidney has been prevented from returning to its seat in this way, it is held down by one hand while it is being palpated by the other. If the pressure of the upper hand is lessened and the pressure of the other hand on the lower border of the kidney is increased, it will be felt to glide up under the fingers of the upper hand into its fossa. A kidney can often be felt with the patient sitting or leaning on the edge of a table, bed or chair, without the individual being lowered into the recumbent position. (See Fig. 234.)

Frequently, it is necessary, in order to palpate the kidney, to place the patient upon the healthy side, in a reclining posture, with the shoulders somewhat elevated and the knees slightly flexed. In this case, it will also tend to fall out of its fossa toward the healthy side of the abdomen. Sometimes, if the patient stands with the buttocks resting against a table, so as to relax the abdomen, this position is favorable to the detection of movable kidney by palpation.

An important point in palpating a kidney is to have the patient take a long breath, and for the examiner to try to grasp the kidney at the height of inspiration. The surface of the organ is usually smooth, though sometimes lobular, and pressure upon it occasionally produces nausea, besides which it is frequently tender to the touch.

Percussion has been of little value to me and so has inspection, although I have seen cases where the contour of the abdomen was changed through enlargement of the kidney, or when, together with a loop of distended colon, it exerted sufficient pressure on one side of the anterior wall of a relaxed abdomen to make it more prominent than on the opposite side.

Diagnosis.—Movable kidney is at times difficult to diagnosticate. A calculous kidney may give rise to attacks of renal colic closely resembling the pains of movable kidney and it may also be enlarged and have a certain limited excursion. A calculous kidney, however, is never as movable and is usually harder. X-ray examination may show the presence of a stone.

Cases of hydronephrosis, due to other causes, have not the mobility of a movable kidney. Tumor of the kidney, while it may resemble a case of movable kidney with hydronephrosis, is associated with induration. I recently had a

case of renal cancer, in which the mass was freely movable; in fact, the pedicle was so adherent to the peritoneum that I considered it a mesonephron. It is a question in my mind whether, in this particular case, the weight of a slow-growing tumor produced this mobility, or whether it was originally a movable or floating organ which was the predisposing cause of the growth. I know from experience that calculi form in the pelvis of a movable kidney, for I have had such cases and I have had others in which tuberculosis developed. I can understand also, how a malignant growth might develop in a kidney of lessened resistance. It is exceedingly difficult, however, to understand the development of a cancer in a movable kidney, although this particular case that I have just mentioned, and which was diagnosticated as such, was movable from the renal fossa, to below and beyond the umbilicus (Fig. 294).

Other tumors of the abdomen do not resemble movable kidney to any degree. I have never seen a gall-bladder that could be mistaken for it; neither have I seen a spleen which I have mistaken for such a condition. In three patients with displaced and movable liver, recently on my surgical service, all my colleagues in the hospital considered them to be movable or displaced kidneys. I demonstrated to them, however, that such was not the case and that although movable kidneys did exist, which I anchored, the livers still remained in the positions in which they were at the time of the examination.

Regarding the tumors and cysts of the ovary and uterine tumors, I will say that I have never seen an ovarian tumor or cyst that I could mistake for a movable kidney. In fact, in tumors of the pelvis, the direction of their extension is so different—upward instead of downward—and the bimanual palpation differs so greatly, that I have never found any difficulty; although I realize that it must be confusing in some cases, as one of the first nephrectomies that was performed was one in which a kidney was removed from the pelvis by mistake, the operator considering it an ovarian cyst. Tumors of the uterus that are movable have their mobility in the pelvis, or in the lower abdomen rather than the upper. Besides this, their consistency is greater, they cannot be pushed up into the renal fossa and bimanual palpation would show them to be wholly or in part in the pelvis.

In case the symptoms point to renal calculus or movable kidney, X-ray pictures should always be taken, as it is occasionally found that a renal calculus is present in a movable kidney. It may also be mistaken for renal tuberculosis, in which case a search for the bacilli should be made in the urine and guinea-pig inoculation resorted to. The course of the two affections is, however, very different and signs of constitutional disturbance, loss of weight and strength, a septic temperature and the urine findings will determine the presence of the more rapidly destructive disease.

Complications.—The complications are, renal strangulation, already mentioned, hydronephrosis and pelvic or reno-pelvic infection.

Prognosis.—Movable kidney has very little influence on longevity, except in cases of a complication in which the function of the organ is interfered with or the patient's general condition is impaired. The severe type of symptoms already mentioned is usually relieved by fixation of the organ.

Treatment.—Preventive and Palliative.—Under preventive treatment must be considered the various predisposing causes that tend to bring about movable kidney or increase its mobility. These are tightly laced or badly shaped corsets, high heels, or any clothes held up by tight belts or bands in men or women who do heavy work by lifting and bending. Certain exercises should be avoided, such as horseback riding or other forms of exercise which tend to pull or bring a strain on the kidney. Valuable procedures are: A well-fitted, straight-front corset or a corset waist with shoulder straps for women; suspenders for men; exercise which develops slowly the abdominal muscles and those of the loin, in this way tending to increase intra-abdominal pressure and regulate the movements of the bowels. Pregnant women should wear well-fitted abdominal belts or supports during the last month, especially if they have a flabby abdomen, and should also wear a similar support after childbirth when they are up and about again. They should be careful, however, not to leave the bed too early.

Palliative treatment includes rest in bed, a liberal diet, massage, electricity, abdominal supports and the remedies which relieve pain during acute attacks. Rest in bed is indicated for women with nervous, neuralgic and mildly painful symptoms. The Weir-Mitchell cure is valuable in these cases, as it helps to restore the nervous balance. Dr. Weir-Mitchell recommends a liberal diet, by which is meant a simple but nourishing one, such as eggs, roast meats—mutton, lamb, beef and chicken—fish, green vegetables, rice, cereals and cooked fruits. Eggs should be boiled or poached; the fish, meats and poultry boiled, broiled or roasted and the vegetables boiled. Sweets should be restricted and fried foods altogether forbidden. In addition milk, malt extract and other adjuncts of a milk diet can be used. A small quantity of coffee in the morning, and milk and black coffee after dinner, are allowed.

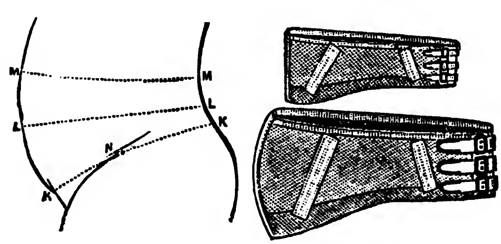


Fig. 274.—Pomeroy's Elastic Abdominal Support for Patients with Movable Kidney.

Massage is a valuable means of strengthening the abdominal walls and loins, and should be employed for from twenty to forty minutes daily. In this procedure, the aim should be not to reach the kidney, but simply to strengthen the abdomen. It should never be given sooner than one hour after meals. Electricity, with the faradic or high-frequency current, is also of value.

Abdominal supports are appliances which tend to press the abdominal wall and its contents upward from the pubes (Fig. 274). They are made of elastic

webbing, similar to elastic stockings, and are laced in the back. Many patients require perineal bands passing between the thighs to hold them in place. Straight-front corsets (Van Orden), if carefully constructed, are valuable as

Fig. 275.—Straight-front Corset for Movable Kidney. (Van Orden.)

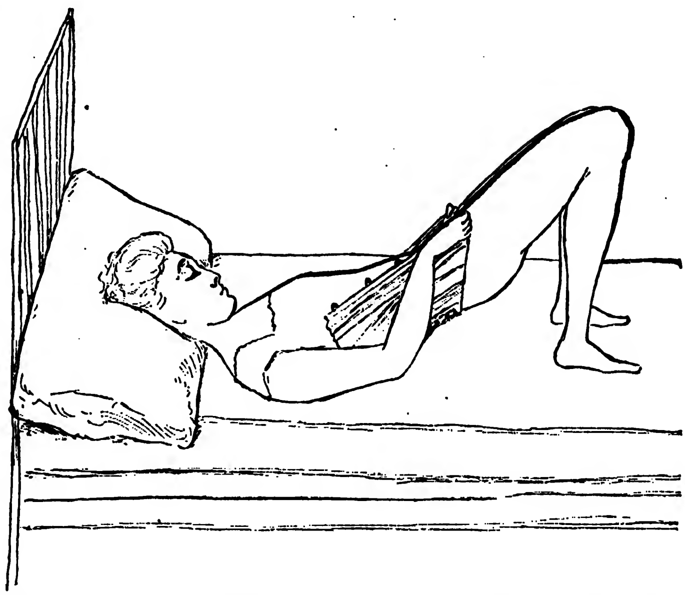


Fig. 276.—How the Corset Should be Put on in Movable Kidney. (Gallant's method.)

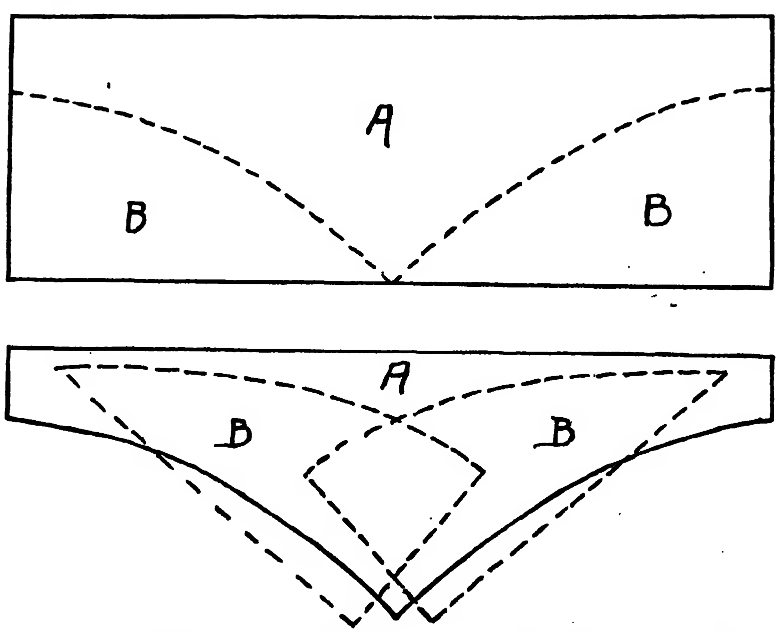


Fig. 277A.—Wide Strips of Adhesive Plaster for Supporting the Abdomen.

a simple and practical abdominal support (Fig. 275). Gallant makes a special point of the manner of putting on a straight-front corset in women. This should be done while she is lying on the back with the pelvis elevated; the corset is hooked first at the lowest part over the pubes, after which the remaining hooks are adjusted from below upward (Fig. 276). Straight-front corsets have the advantage at present of being fashionable, as well as improving the figures of women. It is well to wear a thin cloth band under these elastic supports. Wide strips of adhesive plaster can also be applied for abdominal support (Fig. 277, *A*, *B*). Abdominal exercises are, however, of the greatest importance, as, by developing the muscles of the abdomen, they act as a straight-front corset. (See chapter on Exercise in Urology.)

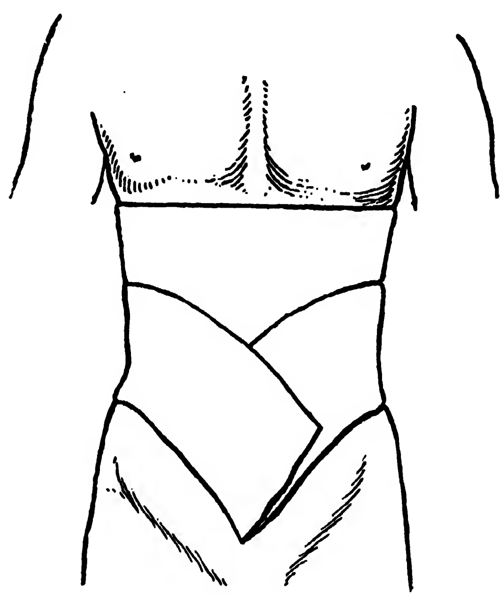


Fig. 277*B*.—The Adhesive Plaster Strips Applied.

In painful conditions, accompanying strangulation of the kidney in Dietl's crises, the patient should be treated as in renal colic, by analgesic remedies, such as morphin, bromids, aspirin, antipyrin, or hot applications, besides any other measures that seem to be indicated. If none of the palliative remedies give relief and if the patient's general condition suffers, or if a complication such as painful colic or Dietl's crises takes place with increased frequency, a fixation of the kidney should be recommended, on the ground that it is better to undergo the trials of an operation than to continue to put up with the continued inconvenience and poor health connected with a bad movable kidney.

If hydronephrosis is present, fixation of the kidney should be urged as a necessary procedure; whereas, in those cases in which movable kidney is complicated by a malignant tumor, tuberculosis, or advanced pyonephrosis, nephrectomy should be performed. If a calculus is present, a nephrotomy for its removal and subsequent fixation of the organ is indicated.

Nephrectomy for the cure of an uncomplicated movable kidney should never be performed. In forty-two such operations reported by Wagner, eleven died, making a mortality of nearly twenty-five per cent.

CHAPTER XXIII

NONSUPPURATIVE NEPHRITIS

(*Bright's Disease of the Kidneys*)

The term Bright's disease has given rise to so much confusion that, were it not for its long usage, it would be advisable to drop the name.

Very little was known concerning the diseases of the kidneys until 1827, when Bright published the histories of some cases of dropsy with albuminuria, together with the autopsy records showing the presence of various kidney lesions. From the study of these cases, he concluded that disease of the kidney was associated with dropsy and albuminuria, and the name Bright's disease was given to kidney diseases with these symptoms.

Wilkes, in 1853, described definitely two forms of Bright's disease as nephritis—the interstitial and parenchymatous—although he admitted that a mixture of the two, forming a third type—the diffuse—might also occur.

Virchow, in 1871, described three forms of Bright's disease: That arising from the vessels (the amyloid form), that originating from the epithelia (the parenchymatous form) and that developing from the interstitial tissue; but he also emphasized that the three forms do not always occur singly, but two, or even all three types, are seen frequently in the same kidney.

In 1879, Weigert published studies which are practically the foundation of the modern view of Bright's disease. He claimed that there was no such thing as a parenchymatous nephritis without interstitial changes, nor was there an interstitial nephritis without epithelial changes. He showed that the many varieties of kidney, small and large, white, red and mottled, which were found at autopsies and which were made the basis of different classifications, in reality depend upon quantitative differences in the amount of congestion, of edema, of fatty degeneration and of interstitial changes.

Brault taught that the best division was, first, acute and chronic nephritis; acute nephritis, to be subdivided into transient acute, hyperacute and subacute; and chronic nephritis, to be subdivided into nephritis with dropsy and nephritis with uremia.

Since the time of Weigert, the classifications of nephritis, etiologically, pathologically and symptomatically, have included hundreds of names, so that

we are pleased to see in the latest book on the subject, by Chauffard, that the old terms "acute nephritis" and "chronic parenchymatous, interstitial and diffuse" are still considered. This will, therefore, be the classification followed in this chapter. The terms dropsical and uremic nephritis will, however, be associated with the names parenchymatous and interstitial.

ACUTE NEPHRITIS

Etiology.—Acute nephritis is usually caused by the germs giving rise to infective disease or to their toxic products. The most important of these diseases, are scarlatina, diphtheria, pneumonia, measles, acute articular rheumatism, influenza, typhoid, malaria, smallpox, cholera, yellow fever; while septicemia, erysipelas and chicken-pox may also be mentioned as causes. The germs of pneumonia and typhoid have been found both in the kidney and in the urine. In diphtheria, the presence of the toxin has been fairly well demonstrated.

Pregnancy sometimes gives rise to an acute nephritis of toxic origin, as a result of the production of placental toxins passing into the system of the mother, that are not properly eliminated.

Exposure to cold is a frequent and most important cause of acute nephritis which is but imperfectly understood. According to Chauffard, cold tends to increase the number of germs circulating in the blood and to promote the passage of germs from the intestines into the circulation. The nephritis due to cold, may, therefore, after all be of infectious origin.

Poisons taken internally may cause acute nephritis, such as turpentine, cantharides, chloroform, ether, mercury, sulphuric and oxalic acids, and the internal or external use of carbolic acid, iodoform and tar. Alcohol, and spices which irritate the kidneys, may also give rise to acute nephritis, if given in large doses. Potassium chlorate, in overdoses, gives rise to hemoglobinuria and acute nephritis. Extensive burns and chronic skin diseases which destroy the function of large areas of skin are also among the causes.

Pathology.—The kidneys in acute nephritis are usually large, heavy, with tense capsules which are easily peeled off. Their surface is either dark red or mottled grayish-red in color, occasionally pale and gray. An incision through the convexity into the pelvis shows that their tissues are rather soft and friable, their cortex swollen, cloudy, gray and yellow and their medullary portion dark and congested.

Microscopically, there are changes, either in the parenchyma alone, or in the interstitial tissue also.

The epithelia of the convoluted tubules are either in a state of cloudy swelling or of granular and fatty degeneration. At times, they are almost completely destroyed and fill the lumen of the canal. Hyaline, granular, fatty and blood casts are found in the tubules. The glomeruli do not show many changes in

the milder cases, save an exudation of albumin within their capsules; in the severe cases, their capillaries are filled with blood, sometimes with thrombi and their epithelia are degenerated or proliferated.

If the interstitial renal tissue is also involved, it is the seat of a swelling or edema between the fibers. The vessels are engorged and their walls are in a state of acute inflammation. Hemorrhages in various parts of the kidney, for example, in the glomeruli, the tubules or the connective tissue, may also be found. In severe forms, a small cellular infiltration is frequently seen in the connective tissue about the capsules of the glomeruli and between the tubules.

The inflammation may terminate in complete resolution, or the condition may be followed by a chronic nephritis.

Symptoms.—Acute nephritis may be subdivided clinically into (*a*) acute transient, (*b*) hyperacute and (*c*) subacute or prolonged nephritis.

(*a*) The acute-transient form includes a group of nephrites occurring during the course of an infectious disease, such as typhoid. There is no edema, nor uremic symptoms; the amount of urine is increased, albumin is considerable and blood slight. The sediment contains hyaline and granular casts and a few red and white blood cells.

(*b*) Hyperacute Nephritis.—This is the result of violent poisoning with bichlorid of mercury, phosphorus, cantharides and other drugs causing great renal irritation, or it may develop in the course of acute infectious diseases, as scarlet fever or diphtheria. The chief characteristic of this type is the rapidly increasing anuria, which is one of the earliest symptoms. It may occur within a few hours after taking one of the poisons mentioned and frequently terminates suddenly in death. There are no major symptoms, such as edema or uremia. Recovery from this form of toxic nephritis is rare and occurs principally in cases following an infectious disease.

(*c*) The subacute or protracted is the most common clinical type of acute nephritis, and its course will be principally considered. It is usually the result of *acute infection or intoxication,* although it may be due to *cold.* The nephritis due to cold and that due to scarlet fever and diphtheria are, perhaps, the most typical representatives of this group.

In both instances, the urine is dark in color, or even reddish, the specific gravity is high, the reaction markedly acid. The urea and the chlorids are lessened. There is always a considerable amount of albumin, two or three grams per liter. Under the microscope, the sediment shows finely and coarsely granular epithelial and blood casts, red blood cells, leucocytes and renal epithelia, some of which are in a state of fatty degeneration.

Their general course in the later stages, especially in severe cases, is about the same, although their onset may be different.

In nephritis due to cold, which is also called *nephritis à frigore,* the onset is usually accompanied by violent pains in the back and loins, a sudden rise of

temperature to 101° F. or more, and a pulse of about 100; vomiting often occurs at the onset.

An examination of the patient at this time usually shows tenderness on pressure over the kidneys, and the organs may be felt to be enlarged. Edema then shows itself, usually as a white puffiness of the face, especially about the eyelids and over the sternum and later about the ankles. The acute process may not extend beyond this stage. In severe cases, the edema increases in the lower extremities, and the pleura, the pericardial and peritoneal cavities may become involved. Subcrepitant râles may also be heard on auscultation, showing that an edema of the lungs is impending. These involvements will give rise to more or less dyspnea. In bad cases, symptoms of uremia may now begin, in which case there will be a diminished amount of urine, headache, disturbance of sight and hearing, and perhaps vomiting and diarrhea may develop. If the uremic condition increases, the tongue will become dry and coated, and delirium or convulsions may set in, followed by coma and death. The symptoms that I have described may all be present in a given case, or only a few of them; they may occur somewhat in the order that I have described or very differently. The nephritis may stop at any point in this list of symptoms and the patient recover. The symptoms of an accumulation of fluid in the serous cavities and an edema of the lungs are very serious, while edema of the glottis in itself is very dangerous. Albuminuric retinitis forebodes a fatal outcome; convulsions are very alarming; and a dry tongue, delirium and coma point to a fatal issue.

Scarlatinous nephritis, representing the type of acute nephritis complicating scarlet fever, diphtheria and other infectious diseases, occurs during the period of defervescence. The symptoms of the onset may be the same as those just enumerated in connection with *nephritis à frigore.* Usually, however, albuminuria is the only symptom noted. On the other hand, the first symptoms may be severe, as edema may set in and rapidly become a general anasarca; whereas, other cases may be characterized by uremic symptoms. The later symptoms will be similar to those mentioned under Nephritis Due to Cold. It is, on the whole, the graver of the forms of protracted acute nephritis.

In either of the varieties under consideration, an increased flow of urine and an increased activity of the skin, as shown by sweating, may come at any time during the disease, and recovery take place; or the symptoms will disappear, with the exception of some albumin and casts in the urine, in which case the disease usually becomes chronic.

Generally, the attacks of subacute nephritis do not reach the stage in which the serous cavities become involved, or in which there are marked uremic symptoms. The active stage of the attack usually lasts for three weeks, during which time the temperature is but slight or ranges from 99° to 101° F., with a pulse of from 90 to 100. If these gradually subside, the patient will prob-

ably recover by the end of six or eight weeks, or else pass into the chronic stage. The blood pressure in acute nephritis is from 130 to 150.

Diagnosis.—Acute nephritis occurring in the course of an infectious disease will not be overlooked if we make it a habit to examine the urine for albumen in every case. The history of the patient will show us whether we are dealing with an acute nephritis or with an exacerbation of a chronic condition. In the latter, the urine shows in the sediment hyaline, fatty casts and fatty or degenerated renal epithelia.

There is also a history of a previous acute nephritis, or an infectious disease. The presence of thickened arteries and of hypertrophy of the heart, as well as changes in the retina, are also points which show that a chronic nephritis has existed for some time and is now in an acute explosion.

The diagnosis between renal hemorrhages from other causes and an acute nephritis with bloody urine is not difficult. In the latter, the urine is diminished in amount and contains renal epithelia, leucocytes and hyaline, granular and epithelial casts. The presence of fever and edema are also signs which help to differentiate the condition from renal hemorrhage. In renal hemorrhage due to tumor, atypical cells and tumor fragments would be found in the urine. If due to stone, crystals would be present, and if due to tuberculosis, tubercle bacilli. The treatment of acute nephritis will be considered later.

CHRONIC NEPHRITIS

As we remarked in the introductory chapters, the terms chronic parenchymatous and chronic interstitial nephritis are no longer regarded with favor by some modern clinicians. What was formerly known as chronic parenchymatous nephritis some now style chronic nephritis with dropsy, and what was known as chronic interstitial nephritis, they call chronic nephritis with uremia. However clinicians may call these two general groups, the autopsy findings show that, although in all cases of chronic nephritis there is more or less evidence of both parenchymatous and interstitial changes, the preponderance of the disease is either in the parenchyma or the stroma. In comparing the autopsy findings with the clinical symptoms during life, it is usually found that the cases accompanied by dropsy are of the parenchymatous type and those accompanied by uremic symptoms are of the interstitial type.

Chronic Parenchymatous Nephritis

(*Chronic Nephritis with Dropsy*)

Etiology and Pathogenesis.—This form of chronic nephritis frequently follows an acute or subacute renal parenchymatous inflammation, or it may also develop without discoverable reason. In the latter case, the real cause of the chronic nephritis is not known, but it is supposed to lie in some toxic influence

which acts upon the kidney through the blood. A variety of causes contribute more or less distinctly to its development. Of these, we may mention frequent or protracted exposure to cold or dampness; overnutrition; undernutrition; perhaps abuse of alcohol; various constitutional diseases, such as tuberculosis, syphilis, gout and chronic malaria; diseases of the heart, especially ulcerative endocarditis; and chronic poisoning with lead or mercury. Chronic parenchymatous nephritis may also be the result of a previous acute infection or intoxication, which was apparently cured and reappeared afterwards in this chronic form. Among the predisposing causes are unfavorable hygienic surroundings, overwork and severe physical strain.

Pathology.—Upon gross examination, the kidneys are generally enlarged and the capsule is adherent in places. The consistence of the kidney may vary greatly. The surface of the organ is pale white or mottled. An incision through the convexity shows the cortex to be narrower than normal, the yellow and white finely striated markings obscured. The medulla is not much changed. The medullary rays are slightly darker than normal.

The lesions in this type of nephritis are always scattered through the kidney in patches or foci, and the appearance of the organ depends upon the arrangement of these foci and the amount of changes in the parenchymatous and in the interstitial tissues. What is known as the large white kidney, for example, is a parenchymatous or a diffuse nephritis mixed with amyloid kidney (Senator). It is characterized especially by fatty degeneration of the tubules and the glomeruli, and fibrous and hyaline changes in the stroma.

The large mottled kidney is the result of lesions in patches, involving both the parenchyma and the stroma. The minute hemorrhages and venous congestion in the cortex give rise to the mottled appearance.

Microscopically, it has been found that all these differences depend upon quantitative relations of the pathological changes in the various classes of tissues of the organ (Senator). The pathological changes in parenchymatous nephritis are found principally in the cortex, especially in the epithelia of the convoluted tubules and less frequently of the straight tubules. These epithelia are in various stages of degeneration, from cloudy swelling to complete molecular necrosis, and are shed more or less freely into the lumen of the tubules, which contain also leucocytes, fat globules, red blood cells and hyaline, fine or coarse granular, epithelial, fatty and mixed casts.

While the type is known as the parenchymatous, there are always some changes in the interstitial tissue (diffuse nephritis). Foremost of these is an edema of the stroma. In the advanced stages, there may be round-celled infiltration or proliferation of the interstitial tissue partly clouding the parenchymatous elements.

The glomeruli are also affected, showing fatty degeneration and necrosis of their epithelia, and an exudate within their capsules. Their capillaries are fre-

quently compressed or blocked by the swelling of the endothelia. The arterioles surrounding the glomeruli are also more or less thickened.

Symptoms.—The symptomatology of chronic parenchymatous nephritis is quite clearly defined. There may be a prodromal stage, characterized by a fever and lumbar pain, but usually the disease sets in insidiously with slight and transient edema, which leads to an examination of the urine and to the discovery of albumin and other evidences of nephritis.

The *edema* first appears on the lower eyelids or on the face, over the sternum or at the ankles. Later, it extends to the legs, the scrotum, the abdomen, the loins and the rest of the body, after which the edema changes its place according to the patient's position. It is greatest in the legs when he stands and greatest in the loins and buttocks when he lies in bed for any length of time. Gradually, effusions may appear also in the pleura, the peritoneum and the pericardium.

The extensive edema of chronic Bright's disease is considered by some as a means of defense, that is, that the toxins which are not eliminated are stored up in the edematous fluid and are thus kept out of the circulation. This theory is proved by finding toxic constituents in serous effusions and in edematous fluids in chronic nephritis.

The *urine* in this form of chronic nephritis is always scanty, clear, of high specific gravity and straw or yellow color. The toxins of the urine are composed of 85 per cent of inorganic products, the principal of which is chlorid of potash, and 15 per cent of unknown organic substances. There is usually a considerable amount of albumin—over 2 grams per liter ($\frac{1}{5}$ to $\frac{3}{5}$ of 1 per cent by weight). The ordinary urinary salts may be normal or increased, save the chlorids, which are diminished. Their retention in the system when the kidneys are affected with chronic nephritis, especially in the parenchymatous form, has been thoroughly demonstrated.

Renal epithelia, numerous fine and coarse granular, epithelial and fatty casts, leucocytes and a few red cells are found in the sediment of the urine.

Cardio-vascular symptoms are not pronounced in this form of nephritis. There may be at the start slight weakness of the heart beats; the arterial tension may be at first slightly lowered. If the nephritis turns toward the chronic atrophy or interstitial form, we note a rise of blood pressure and a marked hypertrophy of the left ventricle.

Course.—The course of the disease in this type of nephritis may be either rapid or slow. If it is rapid, there is a steady increase in the edema and a decrease in the amount of urine secreted. The heart becomes seriously affected, the pulse feeble and rapid. Gradually, the other internal organs are involved. The appetite fails, the tongue becomes coated, the breath fetid. There are often attacks of diarrhea and vomiting. These symptoms, according to some writers, are due to the invasion of the gastric walls by edema. The serous cavities are next attacked and the edema spreads, giving rise to a hydrothorax.

When hydrocardium develops, we find a diffused apex beat, dyspnea and a tendency to syncope. The blood pressure is variable.

These patients with their tense, swollen skin, which is white and dry, present a characteristic appearance. In fatal cases, if death is not due to an intercurrent infection, as, for instance, a broncho-pneumonia, it is the result of gradual exhaustion and finally edema of the lungs or uremia after a hopeless period of disability.

When the course of the disease is slow in evolution, the edemas are much more gradual in their development. The patients are often pale, puffy, with a peculiar luster of the eyes (edema of the conjunctiva) and at times complain of headaches and other minor uremic signs.

Diagnosis.—The diagnosis of chronic parenchymatous nephritis is generally not difficult, as edema, pallor and abundant albuminuria are usually well marked. It is distinguished from acute nephritis (or from an acute exacerbation of a chronic nephritis) by the history of the case and by the absence of acute symptoms, such as fever and blood and blood casts in the urine. It is at times not easily distinguished from amyloid kidney, as amyloid changes may exist with such a nephritis. The diagnosis of an amyloid kidney can only be made when there is an amyloid enlargement of other organs and when there is a history of some cause for an amyloid kidney. In amyloid kidney the quantity of urine is large and the color pale, although there may be large amounts of albumin. We should, therefore, suspect an amyloid degeneration whenever the amount of albumin in a chronic case tends to exceed ten or twelve grams in twenty-four hours. In amyloid kidneys, the urine does not contain granular casts, save in the very advanced cases.

Diffuse Nephritis

This represents the case of chronic parenchymatous nephritis with cardiac and vascular changes, which start as a typically parenchymatous type but go on slowly toward the atrophic or interstitial form. The urine in these cases is more abundant than in the pure parenchymatous, lighter in color, with a lower specific gravity and contains a smaller amount of albumin.

As the disease progresses, and as the heart hypertrophies and the arterial tension increases, the edemas grow less marked, but what appears like an improvement is in reality a transition to the interstitial form.

Chronic Interstitial Nephritis

Etiology.—The development of this disease must be referred to the long-continued action of slight toxic factors, usually of a systemic origin. Concerning the relation of arteriosclerosis to this form of nephritis, arteriosclerosis may be the cause of chronic interstitial nephritis, or, on the other hand, it may be

the result of it, but it is probable that more often both arteriosclerosis and chronic interstitial nephritis are the result of the same causes, such as chronic poisoning with lead, alcohol, gout or syphilis. Diabetes mellitus may also be mentioned as the cause of this form of nephritis. Senator called attention to the frequency with which arteriosclerosis and the accompanying interstitial nephritis is met with in diabetic patients of advanced age.

From what has been said concerning the causes of this condition, it will be understood that chronic interstitial nephritis is rare in childhood and youth, and frequent toward the end of life. The frequency increases with the age of the patient, being greatest between fifty and sixty. Men are more frequently affected than women, because they are more often exposed to the causes above mentioned. Occasionally, there is an hereditary or family predisposition toward this disease. The condition has also been found present at birth.

Pathology.—The essential pathological change in this form of nephritis is a slow hypertrophy of the interstitial tissue, stroma of the kidney, with a gradual disappearance of the parenchyma. The appearance of the kidney varies with the duration of the disease. In the early stages, the kidneys are normal in size or slightly enlarged and mottled. In the advanced stage, they may have shrunken to half their size or even less, one kidney being usually more markedly affected than the other. The capsule is generally adherent in places and contains newly formed vessels. The surface of the kidney is covered with minute red or grayish elevations, showing sometimes small cysts among them. On section, the kidneys are hard and tough, their cortex shrunken, sometimes appearing as a narrow border around the medulla. The medullary rays are also shortened, closely packed and darker in color than normal. The visible arteries show thickened, gaping walls, and at times there are infarcts of uric acid or of calcium salts in the renal tissue.

On microscopical examination, the changes are found chiefly in the cortex and usually are scattered in patches. The interstitial tissue is greatly increased, with here and there some round cell infiltrations. The tubules are compressed or in places obliterated, their epithelia are in a state of atrophy or fatty degeneration or lying loosely detached in their lumen.

The glomeruli are the seat of a cellular proliferation around their capsules, which compress them and render them incapable of functionating. Their loops show increased layers of cells, or else a degeneration of cells, swelling of the epithelia and fatty degeneration of the same. The cavities of the glomeruli may be the seat of an exudate as in the parenchymatous form. Characteristic arteriosclerotic changes are found in the arteries of these kidneys.

Symptoms.—This form of nephritis has always a very slow and insidious onset, and the lesions usually exist for years before the condition is recognized. The disease may be divided into three stages:

(1) The stage of compensation,
(2) The cardiac stage,
(3) The uremic stage.

(1) Stage of Compensation.—In the first stage of the disease, there is a compensation for the gradually increasing involvement of the kidney. The system in some way accommodates itself to the altered conditions. During this stage, there are two classes of minor symptoms that may occur:

(*a*) Those due to arterial hypertension and those due to uremic intoxication.

The symptoms due to arterial hypertension are: Swollen and twisted temporal arteries; occasional attacks of anesthesia in the fingers; slight attacks of epistaxis; noises in the ears and impaired hearing; occasional vertigo.

Those due to uremic intoxication are: Headaches, which are not relieved by drugs but disappear with rest and diet; paresthesia, sensation of cold, heat, formication; cramps in the ankles awakening the patient at night.

(*b*) The urine in this stage of the disease is increased in quantity, and the patient urinates frequently. The urine is pale, clear, usually below 1.010 in specific gravity; the total solids are diminished. There is either no albumin or merely a trace.

(2) The Cardiac Stage.—During the cardiac stage, which follows that of compensation, the system begins to feel the effect of the diseased kidney. The cardiac symptoms of this stage consist in palpitation, attacks of angina pectoris, an increase of arterial tension, hypertrophy of the heart and a *bruit de galop* (galloping sound) which is a marked uremic symptom.

Complications may set in during this stage, some of which may prove fatal before it has fully developed, such as hemorrhages and infections. The hemorrhages may be of great severity, as attacks of epistaxis; retinal hemorrhages that may be followed by more or less permanent blindness; and hematurias resembling those of renal tuberculosis, stone or tumor, during which there may be alarming losses of blood. Hemorrhages into the skin and the mucous membranes also occur, although rarely, during this stage. Some of the infections which may complicate this stage are erysipelas, pneumonia, anthrax and abscess formation.

(3) The Uremic Stage.—During the uremic stage, in addition to some of the symptoms that have already been enumerated under the minor symptoms of compensation are nausea, vomiting, diarrhea and, in the more dangerous cases, convulsions, dry tongue, delirium, stupor, coma.

Diagnosis.—The diagnosis of chronic interstitial nephritis is usually not difficult when the disease assumes its characteristic clinical type. We should pay special attention to the presence of cardiac hypertrophy, as shown on percussion by the increased area of cardiac dullness, by a more diffuse pulsation and by the apex beat being found in the sixth intercostal space, one to three inches to the left of the nipple; to increased arterial tension, which, instead of

being 130 to 140, would be found to be 140 to 180 or higher; to arterial sclerosis, which would show as thick distended tortuous vessels or, later on, as fibrous cords that roll under the fingers; and to a large quantity of urine with a low specific gravity and the presence of albumin and hyaline casts.

There are some cases, however, in which the diagnosis is more difficult, because the condition is marked by a predominance of uremic symptoms resembling chronic bronchitis, gastro-intestinal affections and cancer of the stomach, owing to the cachexia present. In still others, the marked delirium has been looked upon as a sign of progressive general paralysis.

Prognosis.—The prognosis of this form of nephritis is always grave. The disease is incurable, but the patients may live for years and die from some other disease. The only consolation is that the course is usually very slow. The prognosis is worse when the symptoms of chronic uremia or heart failure are present.

TREATMENT OF NEPHRITIS

Treatment of Acute Nephritis.—The first steps to be taken are to have the patient kept in bed, as rest is most important both for the heart and the kidneys, after which an attempt should be made to eliminate the toxins by giving a saline purge, such as sulphate of magnesia an ounce, or compound jalap powder half a drachm; some physicians prefer calomel five grains. A diet which will necessitate as little work on the part of the kidney as possible should then be given, such as milk, three pints a day, or milk with one third part of Vichy. Wet cups should be applied over the kidneys. After these first steps, the patient should be kept on a milk diet; the bowels should be kept open by mild saline laxatives, such as citrate of magnesia, Apenta or Carabaña water; and hot-water bags should be kept over the kidneys. The patient should be allowed to go on without further treatment, unless severe symptoms set in, and may have an uneventful recovery.

In more severe cases, certain symptoms that call for a vigorous treatment occur, such as marked edema with perhaps an involvement of the serous cavities, or those of uremia. A hydragogue cathartic should then be given. Elaterium is the most efficient of all hydragogue cathartics and of value in uremia, but it must be kept in mind that its action is very exhausting. It is best given in combination with the extract of belladonna one quarter of a grain each.

If this is not sufficient to eliminate the toxins, a hot-air bath or pack should be given later. When this fails after waiting for a sufficient interval, pilocarpin should be given. This is most useful in the treatment of renal dropsy and generally exerts a marked diaphoretic action when given internally in doses of from one twelfth to one sixth of a grain.

If the purge, hot-air bath and pilocarpin, together with the saline diuretic, are not sufficient to benefit the patient, then venesection should be resorted to,

followed by an intravenous injection of normal salt solution. In this case, 400 to 500 c.c. of blood should be withdrawn, and the same amount of salt solution should be injected.

When the flow of the urine is scanty, it should be stimulated by giving as a diuretic citrate of potash, ten to fifteen grains every three hours, by which the severe edema and uremia just mentioned can often be prevented.

After the dangerous symptoms subside by this means, the patient should continue with the milk diet and with saline laxatives if constipation is present. The saline diuretics should be given again, as soon as the urine begins to become scanty. If dangerous symptoms again set in, the same vigorous measures should be taken to combat them by means of hydragogue cathartics, hot packs, pilocarpin or intravenous saline injections.

Under such treatment, most patients recover in from six to eight weeks; others become chronic; still others die, especially those developing anasarca and uremia. As the patient's acute symptoms disappear and the urine increases in quantity and elimination is better, the patient can be gradually changed to a more varied liquid or soft diet, as broths, cocoa, bread, crackers, rice and other carbohydrates, and sugar and butter can be added if the digestion permits. Some also allow easily digested vegetables, such as spinach, cauliflower, string beans and peas. In this way, a variety is furnished and the patient is able to maintain a partial milk diet for some time. As a beverage, the patient may have slightly alkaline table waters, or lemonade, or water slightly tinged with wine.

Benzoate of soda and lactate of strontium have been recommended in the treatment of acute nephritis, but they are more suitable for chronic cases. The benzoate of soda acts as a urinary antiseptic and counteracts the causative intestinal fermentation through increasing the flow of bile. The lactate of strontium diminishes the amount of albumin in the urine but does not increase the flow.

For the pain in the loin, dry cups or hot compresses are sufficient. For the hematuria, ergot or tannic acid may be given in the following form (Senator):

Ergot	grs. v (0.3 gram);
Tannic acid	grs. ss (0.03 gram);
Powdered gum acacia	grs. viiss (0.5 gram).

To be taken every three hours.

The constipation which these drugs produce must be counteracted by appropriate purgatives, such as Apenta or Carabaña water.

Treatment of Chronic Nephritis.—This includes preventive, specific, dietetic, hygienic, therapeutic and symptomatic measures.

PREVENTIVE.—The probabilities of a chronic nephritis following an acute attack may be very much lessened by very carefully managing its treatment dur-

ing the acute stage and the period of convalescence. This means keeping the patient quiet and on a bland diet during the acute stage and by not exposing him to bad weather, cold or draught of air while he is convalescing. The diet during convalescence should be very simple and moderate, free from condiments and with a limited amount of animal proteids; or it may be salt free if there is a tendency to edema, or such a condition is threatening.

SPECIFIC TREATMENT.—Most cases of chronic nephritis are incurable. Therefore, the aim of treatment should be to maintain the general health and assist the renal functions so that the patient can continue to live without much inconvenience.

Within the last decade, there have been brought forward certain special methods of treatment which are intended to reach the disease itself and to improve the condition more or less permanently. Organotherapy, the use of renal extracts, is not yet sufficiently known to be recommended. My own personal experience with it has been such as to lead me to prefer the older remedies. The second form of treatment under this category is the surgical, and that of the iodids, the former of which is of very little use, except in the case of certain complications.

The Iodids.—Sodium and potassium iodids, or their substitutes, have been used in chronic nephritis, especially by the older physicians. I frequently use this remedy in doses of two or three grains, three times a day, as a vaso-dilator in arteriosclerotic and cardiac changes. It is also supposed to modify the development of the lesions in the kidney and to prevent the formation of interstitial tissue. Its principal value is in cases of chronic nephritis, in patients with lead poisoning and syphilis, when from two to five grains, three times a day, should be given.

The minor symptoms of chronic interstitial nephritis, due to arterial hypertension and appearing in the shape of headache, occasional vertigo, tinnitus and epistaxis, are also combated with potassium iodid, the action of which should be carefully watched. Alternately with the iodid treatment, glonoin (solution of nitroglycerin) is recommended by Chauffard and may be given in doses of one to two drops. Nitroglycerin has to a large extent taken the place of amyl nitrite in conditions where this drug is indicated.

SURGICAL TREATMENT.—About eight years ago, my colleague, Dr. Edebohls, noticed that many of his cases of movable kidney had in the urine before operation a slight amount of albumin and a few hyaline and finely granular casts which disappeared after partial decapsulation and fixation of the organ. He accordingly concluded, first, that chronic nephritis could be unilateral or bilateral, and second, that, if the partial decapsulation employed in nephropexy was sufficient to cure nephritis, through the increased blood obtained by the anastomosis between the partially decapsulated surface of the organ and the adjoining tissues, then a more extensive decapsulation would give a greater

exposed surface for anastomosis and consequently the recovery would be more certain. He accordingly advocated and began to perform an operation, called renal decapsulation, for the cure of chronic nephritis, which consisted in entirely removing the capsula propria of the kidneys and replacing them in their fatty capsules. He claimed that, by this means, an anastomosis of good-sized vessels formed between the kidney and the fatty capsule, resulting in the cure of the disease.

I performed a number of these operations, but was not satisfied with my results, and accordingly wrote to many of the leading surgeons of the country, asking them to send me a report of the results of their operations. In answer, I received reports of 120 cases that had recently been operated upon, 16 per cent of which were reported cured, 40 per cent improved, 11 per cent unimproved and 33 per cent of deaths. The mortality had been greatest in the cases diagnosticated as diffuse nephritis, 75 per cent of which had died, whereas in the cases diagnosticated as parenchymatous and interstitial, there had been about 25 per cent mortality in each group.

Some time after this, I again wrote to the surgeons who had contributed before and found that, among those of their patients who had survived the operation, 88.5 per cent had since died. The results were accordingly not such as could lead me to advocate renal decapsulation.

There was, however, a class of cases that had been very much benefited by operation and this comprised cases of chronic nephritis, associated with hematuria and nephralgia. These cases were cured of the attacks of hemorrhage or pain by a nephrotomy.

The conclusions that I drew from the studies of my own operations and those of my colleagues were, first, that total decapsulation of the kidney is an unwarranted operation which should never be performed; but that a partial decapsulation of a sufficient area of the surface of the organ to assist in its fixation is helpful in the case of a movable kidney; second, that, in cases of a nonmovable kidney in which there is much tension on account of a tight capsule, this will be removed by simply incising the capsule over the convexity; third, that, if there are symptoms of unilateral nephralgia or hematuria, a nephrotomy is satisfactory, not only as an approved operation, but also as an exploratory means of determining a possibly existing surgical disease.

General Treatment.—Rest in bed is important whenever an acute exacerbation occurs, associated with edemas, scanty or bloody urine, or uremic symptoms, during which time the patient should be treated as a case of acute nephritis. If it is found that rest in bed does not improve the condition of the urine, the patient may be allowed to get up and lounge about the house in reclining postures, especially if the disease is not far advanced. If the heart is hypertrophied and there is much arterial tension, as from 160 to 200 or over, and cardiac symptoms, such as palpitation and angina pectoris, headaches or diges-

tive disturbances are present, rest in bed should be maintained until the patient improves. Periods of rest in bed, for from two to four weeks at a time, say every four months, are of considerable benefit in many chronic cases with a tendency to uremia. The patient's general condition is kept up by massage while undergoing this rest treatment. During these periods, the diet should consist of milk or mixed food, whichever agrees better with the patient.

Many chronic nephritics go on for years attending to their regular pursuits of life without taking any medical treatment for the disease. Many of these patients would never know they had nephritis unless told so by the physician making the urinary analysis. It is important to instruct them as to the protection of back and chest by suitable clothing, the avoidance of draughts, or any prolonged exposure to cold and wet. For the protection of the back in male patients, I recommend a kidney pad or protector during the cold weather. It is easy to see that the winter vests have thick material in front and thin behind. The kidney pad is made of doubled woolen cloth sewed together, of the size and shape of the vest back. There are nine buttonholes in the pad, and nine corresponding buttons on the vest to which they are fitted. The same pad can be used with a number of vests. Besides the protection it affords the lungs and back, I know of nothing of its size that has ever given me so much warmth as has this pad (Fig. 278). It is desirable also that patients should pass a number of hours in the open air every day, if possible, provided the weather is mild and pleasant.

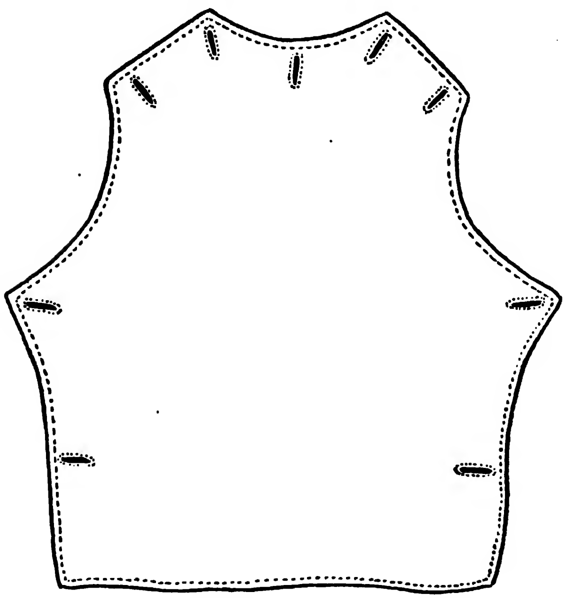


FIG. 278.—KIDNEY PAD TO BE BUTTONED ON THE BACK OF A VEST AS A PROTECTION FOR NEPHRETICS.

Climate.—A change of climate during the winter to a warm, dry, evenly tempered place is of great benefit. Patients are sent to Egypt or Algiers, or to the south of Italy or the Riviera. In this country, Florida and Southern California offer excellent climatic conditions for nephritics.

Diet.—The diet of these patients should be moderate, mixed and nonirritating. They should learn to estimate how much they can eat without doing themselves harm, or else should regulate the diet according to its calories,

and they should know that their longevity depends on eating certain foods and in such amounts as they can easily digest, assimilate and eliminate.

Milk is the ideal food for the patient with Bright's disease, because it is highly nutritious, contains but few toxic substances and promotes the excretion of urine. Yet an absolute milk diet is not necessary except in acute exacerbations, or in cases in which the major symptoms of uremia threaten to develop.

Again, a diet of milk alone is not sufficient in chronic nephritis during the stage of compensation, and, when prolonged, it leads to gastric intolerance and to a general debility with sluggishness in the functions of various organs. Besides, if milk diet be instituted too early, it will be difficult to keep it up later on in the disease when it is indispensable.

When an absolute milk diet is necessary, it should be given in small quantities at frequent intervals. The amount needed for the maintenance of the body weight is about three liters in twenty-four hours, but this is entirely too much fluid and two liters usually mark the degree of tolerance, while one liter daily is sufficient for a short interval or for a longer period if combined with other food. Milk can be taken hot or cold or flavored with a little sugar or a small quantity of cocoa. It is more easily digested when mixed with Vichy or some similar alkaline mineral water. If not well borne, it can be given predigested by means of pancreatin. Substitutes for milk, such as koumiss, may also be used.

Milk diet often causes constipation, thus necessitating the daily use of laxatives or cold-water enemas. Sometimes fecal impactions form, so that enemas of oil or even mechanical removal of the masses is necessary. In other patients, a milk diet causes diarrhea for which bismuth should be used internally.

A diet free from chlorids has of late years taken the place, in a measure, of the absolute milk diet. This method of treatment is indicated in cases of chronic parenchymatous nephritis with dropsy and has already been spoken of. The dropsy can sometimes be made to disappear in patients by giving them a diet free from chlorids, but will reappear again on adding sodium chlorid to the food. An absolute salt-free diet should not be continued for any length of time, as the system requires six grams of salt a day. This represents the amount of salt in three quarts of milk. The amount of salt to the liter is approximately two grams.

The advantage of the chlorid-free diet is that it offers a choice between a number of articles of food. Meat contains very little chlorids, which are lost completely when it is boiled. Eggs, vegetables, potatoes, lentils, rice and farinaceous food contain but small amounts of chlorids. Among the fresh vegetables, green peas, carrots, turnips and string beans may be chosen as containing little salt. In some cases, after a period of such a diet, the patient can return to ordinary food and can tolerate more salt. In other cases, as soon as salt is given, the symptoms reappear.

There is a class of cases, also, in which the salt-free diet does not lessen the edema nor prevent uremia. It is probable that in these cases the exclusion of chlorids from the food is not enough to relieve the system of an excess of chlorids. There are also some patients in whom a chlorid-free diet causes an increased albuminuria. All patients should be carefully watched while on this diet. If the edemas have disappeared, the salt may be gradually increased while the return of symptoms are watched for. If they return, the amount of salt should be reduced again.

Quantity of Fluid.—An important rule in chronic nephritis is never to exceed a definite quantity of fluid ingested in twenty-four hours and in this way to avoid overloading the heart. The heart in these cases is already overworked and must not be strained too much. The average daily quantity of fluid should not exceed one and a half liters. It is for this reason that an absolute milk diet is difficult to maintain without impairing the nutrition of the patient. If we wish to give the patient the full amount of nutriment, we ought to give from three to four liters of milk a day; this is obviously unwise, as we would thus exceed the limit of fluid capacity of the organism.

Van Norden recommends a liter and a quarter of fluid a day and says that a person taking this amount should pass from one and one third to one and one half liters of urine daily.

The liquids besides water allowed in chronic nephritis are milk, lemonades or sour drinks and the alkaline mineral waters, especially Celestine Vichy. Mineral-water cures, as such, cannot be expected to cure the disease, but are sometimes beneficial to the extent to which they improve the patient's general condition. Carlsbad, Vichy and Neuenahr are advised when there is not much hypertrophy of the heart, and but slight increase of arterial tension and no dropsy. On the other hand, when there is a tense pulse and a markedly hypertrophied heart, such springs must be avoided and Marienbad or Kissingen may be recommended. *Carbonic-acid* baths may be used at home when the patient is no longer able to stand the journey to the watering places, and are beneficial in high arterial tension. They are made by charging the water in a bath from a tank of carbonic-acid gas. The duration of the bath should be from eight to twenty minutes, after which the patient should rest for an hour. By this means, the pulse is slowed and the pressure considerably diminished.

Alcohol should not be allowed, or else should be given only in very small quantities in the form of light wines, such as a glass of Bordeaux, or Zinfandel from California, alone or mixed with plain water or mineral waters. Beer and champagne and the stronger wines are very injurious, as they either irritate or cause fermentation, thus interfering with digestion. Whisky with water, well diluted, is allowed by some on the plea of improvement of the patient's nutrition. Alcoholics are less harmful in chronic parenchymatous than in the interstitial form of nephritis.

Coffee, tea and *tobacco* are cardiac stimulants and for this reason should not be allowed, as they tend to overwork the heart and wear it out. Walking patients with a mild degree of nephritis do frequently indulge in all these stimulants, but those with cardiac and vascular changes should be more cautious.

Meat can be allowed to nephritics in a certain amount once a day. White meats are usually recommended, as they contain slightly less extractives and proteins. Veal, pork, lamb and poultry are considered the best, although opinions regarding them vary. I do not attach much importance to the color of the meat, and allow beef and mutton with the same frequency as the white meats. Meat should be taken at the midday meal, which should be the principal meal of the day. They are best prepared boiled, broiled or roasted.

Fish can be taken prepared in the same way. Fish is not as difficult to digest as meat. It is classed by some among the white meats. Once a day is also sufficient for fish and it should not be taken at the same meal as the meat, except in half quantities of each.

Eggs are considered as undesirable food by some and approved by others. In many patients, an egg will increase the amount of albumin in the urine, whereas in other cases it has no effect upon it. Eggs should be boiled, poached or shirred. One egg a day is sufficient for a nephritic and is best taken in the morning.

Vegetables are quite freely allowed in chronic nephritis, although physicians differ in their choice. The allowed list contains rice, lentils, peas, green beans, asparagus, tomatoes, potatoes, carrots and turnips. Personally, I do not allow asparagus and tomatoes, which are on the list because they do not contain much protein matter. I prefer rice, green peas and green beans.

Farinaceous foods are also allowed, as bread, properly toasted, and the cereals, hominy, farina and wheatena. *Fats, carbohydrates* and *fruits* are considered by many as valuable tissue builders in these cases, and can be taken in moderation if they are well tolerated. Grapes and apples are probably the best fruits for nephritics.

From this list it will be seen that the variety is sufficient but that care must be taken not to eat too much, for overeating is one of the causes of chronic nephritis as well as being one of the chief factors in hurrying the death of the patient who is suffering from this trouble. Condiments, as all pickled and smoked foods, spices, pepper, paprika, catsups, mustard, radishes, horseradish and garlic should be interdicted.

Hygiene and Mode of Life.—Persons with chronic nephritis must live strictly according to the rules of hygiene. Excessive exercise and exertion should be avoided, as giving rise to an overproduction of waste to be excreted by the kidney. Rest is essential during acute exacerbations and in the presence of impending uremia. Chronic nephritics are not fit for excessive mental work,

as this is apt to produce indigestion, which indirectly means extra work for the kidney.

The function of the bowels and the skin should be regulated and the patient should avoid extremes of cold and wet.

Symptomatic Treatment.—This is addressed to the symptoms as they arise in the different types of chronic nephritis.

In early cases of chronic parenchymatous nephritis, before cardiac valvular changes have had time to develop, the arterial tension is sometimes so low, that digitalis, caffein and spartein are often used on account of their effect in strengthening and regulating the heart action.

Beginning Edemas.—When a patient with chronic parenchymatous nephritis complains of lumbar pain, while his eyelids appear puffed up and edematous, his urine should be examined and, if evidences of an acute exacerbation are present, he should be put to bed and treated the same as for an attack of acute nephritis.

General edema is threatened when the urine becomes scanty and of a high specific gravity, containing a considerable amount of albumin and casts. A purge of jalap powder or elaterium should be given and diuretic remedies are indicated, selecting those which act upon the glomeruli and promote excretion without irritating the tubules, such as the theobromin preparations. In such cases, the following diuretics should be given until the symptoms have been relieved, when they should be discontinued. Diuretin (salicylate of sodium theobromin) does not irritate the kidney, rarely causes disagreeable symptoms and is a diuretic that I consider most reliable. In the course of the day, from 60 to 120 grains (4 to 8 grams) may be given in divided doses in capsules or solution or hypodermically. Theocin, a synthetic alkaloid of theobromin, has also been found to act as a very reliable diuretic, more so than theobromin itself or caffein, increasing both the excretion of water and solids from the kidney, and useful for the control of dropsy. It is prescribed in small doses, frequently repeated, so as to avoid gastric irritation. Up to 8 grains daily may be given (0.5 to 0.75 gram) the effect being usually most evident on the second or third day after the administration of the drug. Diuresis cannot, however, be maintained by means of this drug, as the system soon becomes accustomed to its use. Agurin, a preparation consisting of theobromin-sodium and sodium acetate, is prescribed in cases of renal dropsy in the form of a powder, to be taken in dilute solution or in capsules, in doses of from 5 to 15 grains three to six times daily. Another very useful remedy in oliguria (scanty urine) is potassium acetate, in 5 to 15 grain doses, every three hours.

Apocynum, Canadian hemp, assists the elimination of fluid that has accumulated in chronic Bright's disease and may be given in doses of 5 to 15 minims (0.3 to 1.0 c.c.) of the fluid extract.

If the threatening edema is not relieved by diuretics and other methods of

treatment already outlined and the edema extends to the lower extremities and serous cavities, as it frequently does in the later stages of parenchymatous nephritis, internal medication should be assisted by physical measures, such as hot baths, followed by packs to promote sweating and thereby favor the elimination of toxins. It is a noteworthy fact, however, pointed out by Landouzy, that 100 liters of sweat would be required as an equivalent of 1,500 grams of urine. Hence, the kidney must always be relied upon as the safest channel of drainage for the impurities of the organism.

In the general dropsy of chronic nephritis, aspiration of the body cavities affords not only a local relief, but the general condition improves, the uremic symptoms are lessened and the diuresis is increased. This is probably due to uremic poisons in the blood leaving the body with the transudating fluid.

The use of Southey's tubes (Fig. 279) have been recommended for the drainage of edematous areas, including the extremities, to relieve the tension of the overdistended tissues. They are made of metal from 3 to 9 cm. long with a lumen of 1½ to 3 mm., resembling trocars, but perforated on the sides. Two or more of these tubes are pushed into the subcutaneous tissue, the stilet withdrawn and a rubber tube attached, leading into a receptacle for drainage. They are left in from twelve to twenty-four hours. The puncture continues to leak for some time after the removal of the tubes. In this way, two quarts of fluid a day will sometimes escape. During the time that operations by renal decapsulation were being performed for the treatment of chronic nephritis, the incision in the loin, made in patients suffering from chronic parenchymatous nephritis, sometimes did not close, but acted as a drain and large quantities of edematous fluid leaked through the loin continuously. Some of the patients operated, who were apparently very stout, having thick abdominal walls, rapidly appeared emaciated after the operation.

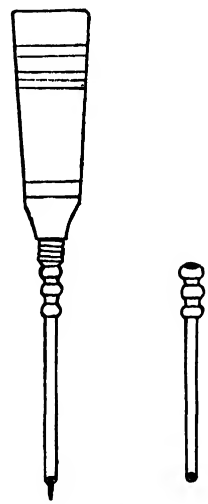


Fig. 279.—Southey's Tubes. (To be obtained from Tieman.)

AMYLOID KIDNEY

Amyloid kidney is a condition of amyloid degeneration in that organ, which usually accompanies amyloid changes in other viscera, such as the spleen and the liver. Amyloid kidney was first described by Rokitansky, in 1842, but the term was introduced by Virchow, in 1855.

Etiology.—Amyloid degeneration of the kidneys is due to any chronic infectious disease which gives rise to a cachexia. Of these, the principal ones are tuberculosis, chronic suppuration and syphilis, but the condition has

also been observed in chronic malaria, in leprosy and in arthritis deformans. Experimentally, amyloid degeneration has been produced by the injection of the bacilli or the toxins of bacillus pyocyaneus.

Pathology.—At autopsy, the amyloid kidney resembles very closely the large white kidneys of chronic nephritis with dropsy (chronic parenchymatous nephritis), so that the conditions are often mistaken for each other. If the surface of the cut kidney is treated with tincture of iodin, the degenerated portions will turn a mahogany brown, while the unaffected portions will remain yellow. If sulphuric acid is then applied, the degenerated zones turn blue.

On gross examination, the amyloid kidney is large, pale, firm and nonelastic, waxy in consistence. Its capsule is smooth and easily detached. On section, the tissue is colorless, often glistening, the cortex swollen and yellowish white, the medullary portion dark.

On microscopical examination, amyloid tissue assumes peculiar coloring with anilin dyes. Thus, with methyl or gentian violet, the amyloid tissue stains pink; with methyl green, the kidney stains a green color except the amyloid portions, which stain violet. The organ should not be fixed in alcohol previous to staining, inasmuch as alcohol dissolves the amyloid substance.

The lesions under the microscope are usually well scattered through the kidney, including the blood vessels, the connective tissue and the epithelia. The blood vessels are the most frequent seat of degeneration, the glomerular capillaries showing amyloid degeneration early in the disease; next, the capillaries of the cortex and last the straight vessels of the medulla. All these arterial channels become gradually obliterated by the amyloid changes. Occasionally, the interstitial tissue is also affected by the amyloid changes. The tubular epithelia themselves, however, are usually free from these changes, although they may be the seat of fatty degeneration.

As the result of the amyloid changes in the arteries and connective tissue, the tubular structures gradually undergo the same changes as are seen in chronic nephritis.

Symptoms.—There are always the symptoms of amyloid degeneration of other organs. The kidney is but slowly affected and the disease develops insidiously.

The chief phenomena are in the urine. A frequent but inconstant symptom is the polyuria, which may amount to from 2 to 6 liters in twenty-four hours. The urine is clear, light colored, with low specific gravity, and contains nothing of importance in the sediment. When there are abundant diarrheas, the polyuria may be absent and the same is true sometimes in the last stages of the disease, when there is heart failure.

The amount of albumin is usually considerable, increasing gradually until it reaches 20 or 30 grams daily. According to Senator, this albuminuria consists in great part of globulin. The urea, chlorids, phosphates, etc., are some-

what diminished in amount. Hyaline and granular casts are sometimes found in the sediment, owing to the presence of a nephritis. But there are never casts having an amyloid reaction.

Amyloid kidney does not give rise to edemas or to uremic symptoms. When these are present, they are due to the accompanying nephritis.

Diagnosis.—The diagnosis is made by the presence of a polyuria, with a large amount of albumin in cachectic patients suffering from tuberculosis or syphilis or some chronic suppurative condition, particularly if there is a hypertrophy of the liver and the spleen to strengthen the diagnosis. The diagnosis from interstitial nephritis is made by the absence of uremic symptoms, of high arterial tension and of cardiac hypertrophy, also because the urine is paler and there is a smaller amount of albumin in interstitial nephritis.

Treatment.—The treatment of amyloid nephritis consists in the maintenance of a mixed diet of milk and vegetables, the administration of iodids in syphilitics and the general care of the primary condition in tuberculosis, etc. When a complicating nephritis exists, it should be treated according to the manner indicated in the chapter on Chronic Nephritis.

CHAPTER XXIV

UREMIA

Uremia (οὖρον, urine, αἷμα, blood) is a toxic condition due to the accumulation or retention in the blood of urine, urinary constituents or excrementitious substances usually thrown off by the kidneys. It gives rise to a more or less complex group of symptoms, such as headache, nausea, vomiting, convulsions, coma, visual disturbance, a urinary odor to the breath and sometimes hemiplegia.

Etiology.—A variety of theories as to the cause of uremia, each based on more or less experimental evidence, will here be mentioned for their historical interest. The condition that is spoken of as uremia was first made known through the work of Bright on nephritis, but the term itself was first used by Piorry, after Wilson had brought forward the theory that the symptoms were due to a retention of urea in the blood (1833).

The principal theories of uremia may be tabulated as follows:

(1) MECHANICAL (Traube, 1861).—Uremia is due to cerebral edema.

(2) TOXIC: MONOTOXIC THEORIES.

(*a*) Due to the retention of urea in the blood. (Wilson, 1833.)

(*b*) Due to the formation of ammonium carbonate in the blood by micrococcus urea. (Frerichs, 1851.)

(*c*) Due to fermentation of ammonium carbonate in the stomach and intestines from urea, and the absorption of the former into the blood. (Treitz; confirmed by Landois and Pavloff.)

(*d*) Due to the accumulation of kreatin, kreatinin, uric acid, etc., as result of changes in metabolism. (Schottin; Voit; Chalvet.)

(*e*) Due to intoxication by the retention of urinary coloring matters. (Thudicum.)

(*f*) Due to intoxication with potassium salts. (Feltz and Ritter. Injection of K. salts in proportion occurring in urine was fatal in animals.)

(*g*) Due to retention of chlorids causing edema of the brain, etc. (Widal and Javal.)

(3) TOXIC: POLYTOXIC THEORY. (Bouchard.)

Not a single toxic substance, but a number of various poisons retained in the blood cause uremia.

Practically all the research work done in uremia since 1881 is based upon

the theory of Bouchard. His definition of the symptom complex is that uremia is an intoxication by poisons, either introduced from without or formed in the body, which are normally eliminated by the kidneys in the urine, but in certain conditions are retained, owing to renal impermeability. According to this investigator, forty-seven per cent of the poisonous effects of the urinary constituents are due to potassium salts; urea, ammonium carbonate, the extractives, the coloring matters, etc., may each play their part in the intoxication. Five distinct poisons, the chemical nature of which is not known, were isolated by Bouchard from the urine.

A series of experimental studies on the permeability of the kidney have been published since, especially in France, and some recent investigators doubt the importance of renal impermeability in the production of uremia (Bernard). Insufficiency of the internal secretion of the kidneys and the liver, with failing compensation of the heart and increasing arterial tension, are believed by them to be sufficient etiological factors, without any renal impermeability. The significance of toxic retention and renal impermeability is held by other observers, who explain the occasional absence of toxic substances from the blood in uremia by their absorption on the part of the tissues. (Castaigne, Achard.)

The retention of chlorids in the body has also been pointed out as a factor in the mechanism of uremia. (Widal and Javal, Bohne.) According to Castaigne, uremia is due to the retention in the body of multiple toxins from various sources and the retention of chlorids, both being the result of renal impermeability, without which no uremic poisoning can take place.

The occurrence of uremia is dependent upon (1) the presence of a renal disease, either acute or chronic nephritis, pyelo-nephritis or pyonephrosis, cystic kidney or renal abscess; (2) upon the presence of renal obstruction, such as calculus in the ureter, ureteral stricture or pressure upon the duct, in the bladder or somewhere along its course.

Patients suffering from an acute affection of the kidney producing anuria, such as acute nephritis or an acute exacerbation of chronic nephritis, are liable to an acute attack of uremia. In the absence of predisposing factors, patients with chronic disease of the kidney may remain free from uremic manifestations for years. The causes that favor or immediately induce the appearance of the uremic symptom complex may be summed up as follows:

(1) Increase in the work of the kidneys, due to overeating or drinking.

(2) Intercurrent acute nephritis, exposure to cold, wet, fatigue, any cause producing congestion of the kidneys.

(3) Complicating extrarenal intoxications: Influenza (in old age) and other acute infectious diseases occurring in chronic nephritis.

(4) Arrest or diminution of toxin elimination, by treatment or conditions which arrest sweating, defecation, vomiting and urination.

Symptoms.—The symptoms of uremia vary according to the character, strength and degree of the intoxication, as well as the predisposition and resistance of certain organs or groups of organs. Clinically, there are two varieties of acute and chronic uremia. Acute uremia may occur in acute nephritis, or in the course of chronic lesions of the kidney, and may be the first indication of the presence of renal disease.

Acute Uremia.—The hyperacute form is characterized by a sudden attack, without premonitory symptoms, of faintness, vertigo and coma, which is followed by death within a short time. As a rule, such patients for months or years have been suffering from chronic uremia, but the true nature of their illness has remained unrecognized to the end.

The acute form also comes on suddenly, but is preceded by premonitory symptoms, such as headache, vomiting, oliguria or anuria, or disturbances of vision and hearing (contraction of the pupil, double vision, partial or total blindness, noises in the ears, sudden deafness). There may have been also slight delirium and a tendency to aphasia.

The acute attack is characterized by convulsions, delirium, somnolence and coma. There may also be intense dyspnea, asthmatic breathing or Cheyne-Stokes respiration, or the dominant symptom may be vomiting and diarrhea. Paralyses have been reported in this connection, especially by French writers.

Latent or Mild Uremia (Lecorché and Talamon's Attenuated Uremia).—There are cases of chronic disease of the kidneys in which the uremia is so mild and is accompanied by so few typical symptoms, that it is apt to be mistaken for some less serious trouble. Only when the urine is repeatedly examined and the case studied thoroughly, may we make out the uremic origin of the mild symptoms complained of by the patient.

This mild form of chronic uremia may persist for a long time without becoming aggravated, or it may be the precursor of the more severe type known to the French writers as "*grande uremie.*"

Headache is the leading symptom in many such cases of mild uremia. It may for a long time be the only symptom present, and may vary greatly in intensity. Next to headache, there are a variety of muscular and neuralgic pains which frequently accompany mild uremias. Uremic intoxication may give rise to a neuritis like that of alcohol and lead, and one form of such a neuritis is that of the cardiac plexus known as angina pectoris. Facial and other neuralgias may also occur in mild uremia.

A variety of aches in the muscles and the joints, and cramplike contractions of the sole of the foot, are also complained of. The patients behave like rheumatics and are frequently given salicylates erroneously. Numbness, pricking sensations in various parts of the body, including the common phenomenon of "dead finger," may also occur. (Dieulafoy.)

Finally, the mild form may be accompanied by disturbances of vision and hearing, of which we shall speak further on, and occasionally there are attacks of asthma without any organic cause, due to toxic influence.

Chronic Uremia.—In the chronic form, the symptoms are usually rather indefinite. Headaches, neuralgias, respiratory disturbances, attacks of asthma or disturbances of vision or hearing, come on at irregular intervals, provoked usually by exposure to cold, fatigue, or excesses in eating or drinking. Gradually these attacks become more frequent, and the final stage is heralded by a period during which vomiting, diarrhea and loss of appetite are prominent. The patient loses weight, becomes weak and anemic, and gradually grows somnolent, apathetic and semicomatose. Death comes on either in deeper coma and exhaustion, or preceded by an acute exacerbation of the symptoms, with convulsions, coma and paralysis.

Groups of Symptoms.—Having thus sketched the clinical evolution of the principal forms of uremia, we should now consider more in detail the individual groups of symptoms observed in this condition. Many signs of uremia occur in other conditions and it is for this reason that the diagnosis of uremia is not easy to make. In each case, a careful study of the mass of symptoms is needed. The clinical picture, however, can usually be subdivided into various groups or classes of symptoms, one or more being represented in the case studied:

(1) NERVOUS SYMPTOMS.
- Headaches.
- Neuralgias.
- Disturbances of cutaneous sensation, e. g., tingling, formication, "dead finger."
- Restlessness, confusion of ideas, partial aphasia, somnolence, disturbed sleep, apathy, depression, convulsions, delirium, coma, paralyses.

(2) CARDIO-RESPIRATORY SYMPTOMS.
- Dyspnea.
- Uremic asthma.
- Cheyne-Stokes breathing.
- Bronchitis, pleurisy, pulmonary edema, hydrothorax.
- Heart symptoms, due to affection of the heart which may coexist. Usually cardiac hypertrophy and increased arterial tension.

(3) GASTRO-INTESTINAL SYMPTOMS.
- (a) Mouth and Pharynx:
  - Dryness, thirst, difficulty in swallowing.
  - Stomatitis (catarrhal or ulcerative).
  - Salivation.

(*b*) Stomach:
Anorexia, dyspepsia.
Nausea or vomiting.
(*c*) Intestines:
Diarrhea (serous or dysenteric), constipation.

(4) SKIN SYMPTOMS.
Pruritus.
Erythema papulosum and maculosum.
Urticaria, purpura.
Hyperidrosis.

(5) EYE SYMPTOMS.
Miosis (contracted pupils), mydriasis.
Disturbances of vision, double vision, amaurosis.
Optic neuritis.

(6) EAR SYMPTOMS.
Tinnitus (ringing) or other noises in the ear.
Deafness (sudden).

(7) URINARY SYMPTOMS.
Oliguria or anuria in acute form.
Quantity normal or increased in chronic forms (but quality suffers).
Urea diminished.
Albumin usual (not invariably present).
Functional efficiency of kidneys low (cryoscopy, phloridzin test, etc.).

(8) GENERAL SYMPTOMS.
Emaciation, atrophy of muscles, edema.
Pulse slow, high tension.
Temperature subnormal or febrile.

Nervous Symptoms.—Some of these are characteristic of the prodromal period. The uremic headache is one of the early symptoms, and is usually very obstinate, sometimes occurring in the form known as migraine. Headache, accompanied by apathy and stupor, may also be present during the attack itself.

A variety of neuralgias often depend upon incipient uremia. These include particularly occipital neuralgias and angina pectoris. Pains in the limbs and joints and disturbances of sensibility may also occur as prodromal signs.

During the attacks of uremia, the serious nervous symptoms may be divided into the signs of excitement and those of depression. The former include convulsions which may assume the type of eclampsia or epilepsy, general or partial clonic contractions, which are the usual types. These convulsions present nothing specially characteristic, and the differential diagnosis from epilepsy,

etc., must be made from delirium, coma and the other symptoms above mentioned.

Delirium is another symptom of this group. The patient may suffer from confusion of ideas, mutter incoherent sentences, and have illusions and hallucinations. In other patients, the delirium seems to be more specific in character—they rave about one subject, often persecution, or they become moody and melancholy and may attempt suicide.

Coma is one of the most typical symptoms of the uremic attack. In the acute form, it comes on rapidly, in the chronic form more gradually, but in both the same features prevail as a rule. It is accompanied by anuria or oliguria, a subnormal temperature, a slow pulse, slow, irregular breathing (Cheyne-Stokes). The muscles are completely flaccid, the face is pale, the pupils contracted and consciousness is entirely lost.

Paralyses have been observed in a large number of cases of uremia, especially those due to chronic nephritis. They vary in intensity, and disappear if the patient recovers. The affected muscles, usually those of one arm, are always perfectly flaccid. Occasionally aphasia has been observed in these cases.

Respiratory Symptoms.—The dyspnea of uremia may be either toxic or pulmonary. The toxic form occurs after exertion and overeating. It is easily cured by simply adopting a milk diet. Typical asthmatic symptoms accompany the dyspnea. The patient is unable to lie down in bed, and complains of constant oppression on his chest, breathes rapidly and emits sibilant râles. The attacks come on at night, without asphyxia.

In another type of cases, there is actual asphyxia associated with the dyspnea, and the patient may die during the attack.

Cheyne-Stokes breathing is an abnormal type of respiration not characteristic of uremia, but present during the attacks, in the comatose stage. The extent and rapidity of the respiratory movements are gradually lessened, until the patient's breathing is entirely arrested for several seconds; it is then resumed again at a gradually increasing rate and depth. It is always a serious symptom, pointing to deep involvement of the cerebrum.

Bronchitis, pulmonary edema and hydrothorax may accompany uremia and give rise to pulmonary dyspnea. Pulmonary edema is often a fatal complication of uremia.

Gastro-intestinal Symptoms.—In acute uremia, vomiting is a frequent and important symptom, but the chronic uremic state may show many more signs on the part of the gastro-intestinal tract, including all those mentioned in the table. The toxic agents causing uremia are evidently, at least in part, eliminated through the mucosa of the gastro-intestinal tract, instead of through the insufficient kidneys, and accordingly the entire tube from mouth to rectum may be affected. Dryness of the tongue and throat and thirst are frequent pre-

monitory symptoms of a uremic attack. Stomatitis is rare, but must be looked out for.

The vomiting at first occurs after meals; later it is more frequent and occurs independently of eating. The vomited matter contains urea and ammonium carbonate and is alkaline in reaction. Under these circumstances, vomiting is a grave sign, showing that the toxemia is general and profound, and the renal insufficiency very marked, so that the organism has recourse to emesis to rid itself of the accumulated poisons.

Usually, the diarrhea is of the ordinary catarrhal or muco-serous type, frequent fetid fluid stools being the chief symptom. There are cases, however, in which intestinal ulceration leads to a dysenteric diarrhea. Alternate constipation and diarrhea are often present.

Eye Symptoms.—The ocular symptoms of uremia should be carefully distinguished from those of chronic nephritis. The former are not accompanied by ophthalmoscopic changes; the visual disturbances are of sudden onset and transitory in character (double vision, hemiopia, hemeralopia, amblyopia and amaurosis). At the height of a seizure, the pupils are dilated and do not react to light or only feebly so, whereas a chronic uremic poisoning not an attack produces a contraction of the pupil. Edema of the optic sheath has been noted in cases where the pupils fail to react. The presence of an albuminuric retinitis is shown by the ophthalmoscope. Amaurosis, always bilateral, may be the only symptom of uremia in certain exceptional cases, and in conjunction with headache is often the forerunner of an attack.

Urinary Symptoms.—The urinary symptoms of uremia vary according to the original cause of this condition in a given case. The quantity of urine excreted is greatly diminished (oliguria), or there is total absence of urinary secretion (anuria) in acute forms, due to acute parenchymatous nephritis, to an acute exacerbation of a chronic parenchymatous nephritis, or to acute obstruction of the urinary tract.

In chronic interstitial nephritis, on the other hand, there is an increased amount of urine (polyuria) of low specific gravity. The amount of urea is generally diminished considerably, the daily excretion becoming less and less in the fatal cases until it reaches zero at death. Usually there is some albumin, but this may be absent. The functional efficiency of the kidney as tested by the cryoscope, the phloridzin test and other means is very much impaired, especially in uremias due to interstitial nephritis.

Among the clinical urinary symptoms, nothing characteristic of uremia can be noted. There may be frequency of urination, retention with overflow, incontinence and a musty odor of dribbling urine soaking into the bedclothes. These symptoms depend upon the primary condition of the urinary organs, inducing uremia, the presence of renal or vesical infection, urinary obstruction, etc.

In the comatose condition of uremia, retention of the urine may occur from inability to feel the impulse to urinate. In such cases, the urine either dribbles away as the bladder overflows, or, if the coma is not so profound, the patient voids the entire contents of the bladder involuntarily at intervals. Of course, this does not refer to the urinary retention due to obstruction which may and frequently does appear with uremia, especially uremia as it comes to the knowledge of the surgeon. (Compare sections on Incontinence and Retention.)

General Symptoms.—Acute uremia may occur in apparently perfectly healthy persons. Chronic uremia, with its attendant renal insufficiency and gastro-intestinal troubles, leads to pallor, emaciation, cachexia and weakness of the muscles, which become atrophied. Edemas may be present, especially in patients with cardiac complications and cirrhosis of the liver.

The pulse of uremia is characteristically slow and of high tension. This is the result of the intoxication and of the condition of the arteries in chronic nephritis. High-tension pulse in a nephritic is, indeed, considered by some as a sign of impending uremia, although fatal uremias may be accompanied by a comparatively low arterial tension.

The temperature during the attack tends to become subnormal as the symptoms increase in gravity. Fever may, however, be present if there is an infection of the kidney or any other organ, and also in some of the acute cases, due to acute nephritis.

Diagnosis.—A correct interpretation of a given symptom as a sign of urinary intoxication is not always easy. A symptom may be looked upon as uremic in origin, (*a*) when it is associated with other signs pointing to uremia; (*b*) when it occurs without any organic basis of disease in the organ with which the symptom is associated (e. g., the stomach and the intestine); (*c*) when it is associated with renal disease, alone or in combination with lesions of the lower genito-urinary tract. A careful examination of the urinary organs and of the urine is essential for a diagnosis of uremia.

If there is no residual urine in the bladder, no obstruction to the discharge of urine, no oliguria or anuria, and if a fresh specimen and a twenty-four-hours' specimen of urine are found to indicate normal function of the kidney, the symptom thought to be uremic in origin must be ascribed to some other cause.

On the other hand, uremia is diagnosticated by the presence of the symptoms or groups of symptoms above described, when the urine shows a deficient renal function.

For the purpose of obtaining an estimate of the kidney function, we resort to the methods of functional diagnosis described in detail in the chapter on Examination of the Kidney. Of these, the most valuable in the diagnosis of uremia are the determination of the specific gravity, of the total solids excreted, of the percentage of urea of the total nitrogen in the urine and the measurement of the freezing points of the urine and of the blood (cryoscopy).

The retention of toxic substances in the blood and the deficiency of elimination of these substances by the kidneys are expressed in uremia by (1) a lowered specific gravity; (2) a diminished amount of total solids excreted in twenty-four hours; (3) a low percentage of urea and of nitrogen; (4) a lowered freezing point of the blood, owing to its greater concentration; and (5) a raised freezing point of the urine (nearer zero, owing to the lowered concentration).

Differential Diagnosis of an Attack of Uremia.—Uremic unconsciousness coming on suddenly, as in chronic interstitial nephritis, may simulate (1) cerebral hemorrhage, (2) meningitis, (3) epilepsy and (4) certain intoxications.

(1) Cerebral Hemorrhage.—In apoplexy, which is so commonly associated with kidney disease and arteriosclerosis, the sudden loss of consciousness may simulate a uremic attack; but the mode of onset as well as the existence of complete hemiplegia, with the eyes turned toward the lesion and away from the paralyzed side, suggest cerebral hemorrhage. The distinction is extremely difficult, if not impossible in certain cases.

(2) Meningitis.—Meningitis, in which there is deep coma, with rise of temperature, a furred tongue and no localizing symptoms, is also easily confounded with uremia; but the mode of onset, the rigidity of the neck, incoherence or mild delirium, photophobia and pronounced fever, point to a lesion of the brain.

(3) Epilepsy.—The fulminating or eclamptic type of uremia is very suggestive of epilepsy. The principal distinctive feature between uremia and epilepsy is that uremic attacks are usually preceded by headache, vertigo and nausea, and occur without an injury to the tongue. The onset of an epileptic attack is sudden, with tonic and then clonic convulsions, beginning generally with biting of the tongue. A history of former seizures is sometimes obtainable. The urine during and after a paroxysm of epilepsy may contain albumin. When the convulsions are uremic, albumin and casts may both be present. Edema, especially under the eyes, would point to uremia. The ophthalmoscopic examination of a uremic patient would show degenerative changes in the retina.

(4) Intoxications.—Uremic coma may be mistaken for poisoning by opium or alcohol. In opium poisoning the pupils are contracted, whereas, in an attack of uremia, they are dilated. According to the type of uremia, the pupils may be either widely dilated, of medium size or contracted, but in a so-called attack of uremia, when a diagnosis is most important, they are dilated, the contracted pupil being characteristic of chronic cases. The examination of the ocular fundus with the ophthalmoscope, to determine the presence or absence of albuminuric retinitis, is a valuable diagnostic adjuvant. The urine should be drawn off and examined in all suspected cases.

In the differential diagnosis of uremia from alcoholism (state of drunkenness), an alcoholic odor of the breath sometimes is a most important point. In

alcoholic intoxication, the pupils are somewhat dilated, but not as markedly as in uremia. The condition of the heart and arteries must also be taken into account in cases of elderly individuals who may be suffering from arteriosclerosis. The delirium in alcoholism is not accompanied by convulsions, and the coma is not so deep as in uremic poisoning. It may for a time be impossible to determine whether the condition is due to uremia or to profound alcoholism, as one of the principal causes in precipitating an attack of uremia in a nephritic is overindulgence in alcohol. In many of these doubtful cases, uremia can be identified by the history given by the family, the age of the patient and the marked arterial tension. The presence of dropsy in some cases is a valuable indication of the nephritic origin of uremic symptoms.

Uremic coma must also be differentiated from diabetic coma. The examination of the urine would show the presence of sugar and further tests with the tincture of the chlorid of iron would show the Burgundy-red reaction of acetone.

Acute Prolonged Uremia.—The differentiation of uremia from certain infectious diseases is sometimes difficult. The uremia may persist for weeks or months, the patient lying in a condition of torpor or even unconsciousness and slight fever, with a heavily coated and also, perhaps, dry tongue, a rapid feeble pulse and muscular twitchings. This state naturally suggests the existence of one of the infectious diseases, such as typhoid fever or acute miliary tuberculosis.

There is no absolute rule applicable to the differential signs. The table (page 450) which I have written out is appended simply as an aid in doubtful cases.

Prognosis.—Uremia, once diagnosticated, should always be a source of anxiety to the attendants of the patient, because there is an element of uncertainty in the manner in which the intoxication will affect a given case. A peculiarity of uremia, which should not be overlooked in making a prognosis, is that the degree of actual intoxication and the severity of the symptoms do not always correspond with the gravity of the lesions in the renal apparatus. In some patients, the subjective and even the objective symptoms may be quite severe, while the renal function is very fair; whereas, others exhibit remarkably few and mild symptoms with very much impaired renal functions.

The type of uremia has no very pronounced bearing on the prognosis. The mild latent form may exist for years, but eventually the grave form develops. The chronic form toward the end may become more and more severe, the attacks increasing in frequency, until one of them ends in death. The acute form may either subside and, if its cause be removed, leave the patient in good condition, or it may end fatally, or it may develop into the chronic form.

The cause of death may be one of the following: (1) Death in coma, sometimes following convulsions; (2) edema of the lungs; (3) asthenia.

	Apoplexy.	Epilepsy.	Diabetes.	Alcohol.	Opium.	Uremia.
1. Coma	Sudden, deep.	Sudden loss of consciousness.	Sometimes sudden, more often gradual.	Gradual.	Gradual.	Sudden.
2. Convulsions	Rare.	Tonic then clonic.	Rare, may occur before death.	None.	None.	Frequent.
3. Respiration	Labored, stertorous.	Irregular, stertorous.	Accelerated or disturbed.	Unaltered.	Slow.	Dyspnea, hissing stridor. Cheyne-Stokes.
4. Pulse	Slow, full, hard, irregular.	Extremely high arterial pressure.	Very feeble and rapid.	Frequent and weak.	First strong, later weak and rapid.	Slow, becoming weak.
5. Pupils	Unequal; turned away from paralyzed side.	Dilated, later irregular.	Unaltered.	Dilated.	Contracted; sometimes dilated in very advanced stage.	Dilated in acute attack.
6. Paralysis	Hemiplegia.	None.	None.	None.	None.	Paralysis rare.
7. Urine	Generally negative. May contain albumin and even sugar.	Generally negative. May contain traces of albumin.	Gradual fall in quantity and specific gravity.	Generally negative.	Unaltered.	Albuminous, may contain casts.
8. Facies	....	....	Pallor, sometimes cyanosis.	Red face and nose.	....	Pallor; edema under eyelids.
9. General	Apoplectic habit; heart may show hypertrophy.	....	Cold extremities.	Heart often weak; dilated. Arteriosclerosis.	Irregular heart action.	Heart dilated.

A case which occurred in one of my hospital services was in a boy aged twenty-one years, who had total suppression of urine and lived for eight days after the removal of a large tuberculous kidney. At no time during the post-operative eight days did he show any signs of uremia and was conscious almost to the end. Death occurred from asthenia. The autopsy revealed the absence of a second kidney.

Treatment of Uremia.—When convulsions are frequent, the face red and cyanotic, the pulse full, venesection is, in my judgment, the most effective remedy. The causes of the benefit derived from venesection are probably four: (1) Withdrawal of a part of the poisons circulating in the blood; (2) lowering

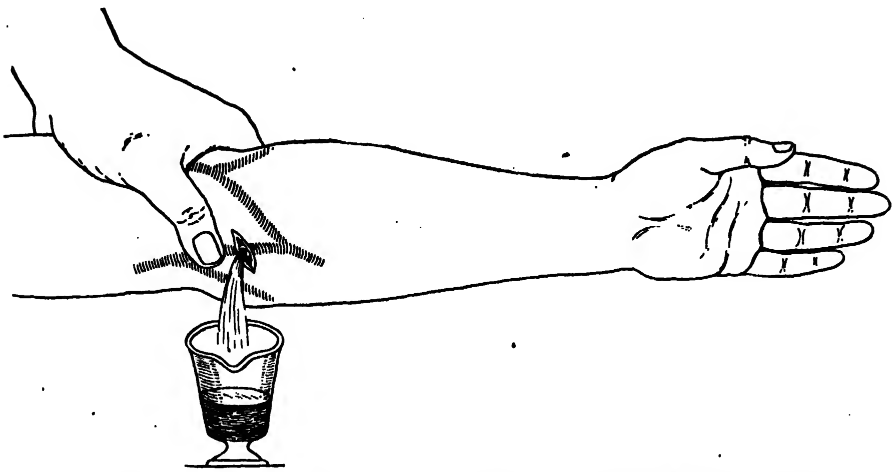


FIG. 280.—BLEEDING THE PATIENT IN UREMIA. (See also Figs. 258, 259, 260.)

of the blood pressure; (3) dilution of the blood, i. e., lessening the viscosity, and hence a reduction of the work of the heart and of friction along the vessels; and (4) the lowering of temperature (Fig. 280). It is usually followed by an intravenous injection of a corresponding quantity of normal salt solution. (See Intravenous Injections of Saline Solution in chapter on the Use of Water in Urology.)

The subject of the lessening of the viscosity of the blood brings us next to the employment and effect of inhalations. By this easy means, agents that enter the blood rapidly may be given, with a notable effect upon the convulsions when present. Chloroform is among the first, a few whiffs lessening the motor symptoms in a marked manner.

For the dyspnea, iodid of ethyl may be inhaled with relief, from a small vial held in the hand, or ten to twenty minims on a handkerchief. The internal administration of morphin and heroin markedly relieves the dyspnea and the convulsions. When the convulsions are marked by high tension, the vaso-dilators, glonoin or spirits of nitroglycerin (2 to 5 drops every three to four hours), amyl nitrite (♏ v from a crushed capsule), cautiously inhaled, is

sometimes employed, and must be regarded with favor under the proper conditions.

Ammonia, a remedy too little used, exerts a direct liquefying action upon the blood, reducing its molecular concentration, and contributing to the oxidation of other nitrogenous compounds. The aromatic spirits of ammonia (thirty to sixty minims in water) are serviceable, stimulating the movements of the stomach and intestines. In the most pressing cases, ammonia can be injected directly into a vein of the leg.

In an acute attack of uremia, there often are symptoms of approaching weakness of the heart, a small pulse, so small at times as to be imperceptible, and very faint respiration. Under these circumstances, the aromatic spirits of ammonia are very useful, and it may be well to support the heart with injections of digitoxin, $\frac{1}{100}$ grain; camphor, $1\frac{1}{2}$ grain in oil; caffein sodium salicylate, $\frac{1}{2}$ to 2 grains; and ether, f℥ss or more in cold water. After venesection, isotonic injections of warm saline solution into the veins or into the loose cellular tissue of the flanks, groin and axilla, are given.

In all cases of acute uremia, an effort should be made not to overtreat the patient by too violent purging, which is very exhausting and often not as efficacious as the milder methods above mentioned, or the simple diuretics and dieting. As to the convulsions, there are no better remedies, if swallowing is possible, than the bromids.

The treatment of chronic uremia is considered under Chronic Nephritis.

CHAPTER XXV

CHRONIC SUPPURATIVE DISEASES OF THE KIDNEY

(Pyelitis, Pyelo-nephritis, Pyonephrosis, Perinephritic Abscess, Nephritic Abscess and Suppurative Nephritis)

During the last two decades, there have been rapid changes in our views of the pathology and bacteriology of the kidney, due principally to the exhaustive investigation of the French school.

Notwithstanding, however, that much light has been thrown upon the causes of these diseases, the variety and manner of infection, their scope and line of march, the clinician is still constantly at a loss to know in any case before him whether one of these affections exists alone, or whether two or more are combined. The diseases of this variety, however, that have come under my personal observation, were usually combined, instead of existing as one single, well-defined disorder.

I may here say, in a general way, that I consider the diseases closely associated with one another in their line of march to be: Pyelitis—an inflammation of the pelvis of the kidney; pyelo-nephritis—a pyelitis plus nephritis; pyonephrosis—a pyelitis plus a nephritis, together with enlargement of the pelvic cavity due either to destruction of renal tissue by abscess, or to dilation of the pelvis from obstructions lower down the canal, or to both these causes; and perinephritic abscess—a collection of pus about the kidney. Abscess of the kidney and suppurative nephritis occurring independently of the above group, will be considered later. They are comparatively rare.

As the scope of this work is clinical, I will endeavor to consider these diseases from a clinical standpoint, whatever may be their etiology. I will, therefore, include in this consideration tuberculosis and calculus, as they have been in my practice such frequent predisposing causes of renal suppuration.

PYELITIS

Etiology.—The causes of these suppurative diseases of the kidney are practically the same, whether the inflammation begins in the pelvis and extends to the parenchyma, or whether it begins in the parenchyma and extends into the pelvis. They are predisposing and active causes. The former include, in the

first place, debilitated conditions of the body which favor suppuration; infectious diseases; any factor leading to congestion, as traumatism from direct contusion; the irritation of drugs, exposure to cold or wet and displacement of the kidney due to great mobility.

Other predisposing causes are found in all conditions which interfere with the urinary flow or congest or irritate the kidney; in the first instance—urethral strictures; enlarged prostate; vesical stone or tumor; ureteral stone, tuberculosis or stricture; or outside pressure upon the ureter due to adhesions or growths: and in the second instance—a stone; tumor; tuberculosis of the kidney or its pelvis; or abnormal renal mobility.

In tuberculosis with suppuration, the pelvis may be involved in an ascending process from the bladder or in a descending process from the kidney tissues, usually the latter. The tubercles developing in the renal pelvis may break down and suppurate at the same time that a similar process is going on in the kidney proper.

Usually pyelitis is a part of a pyelo-nephritis or pyonephrosis, and, in most cases in which the predisposing cause of the pyelitis is not removed or relieved, the disease secondarily affects the kidney, at least in its medullary portion: whereas, on the other hand, in the great majority of cases in which the suppurative process begins in the parenchyma, the inflammation in turn extends to the pelvis.

The active causes of these suppurative conditions are the various pus-producing germs, the most common of which are the colon bacillus, staphylococcus, streptococcus, Proteus vulgaris, Bacillus pyocyaneus. The gonococcus is a pus producer, but it is rarely the active microörganism giving rise to the renal suppuration. The tubercle bacillus is not considered as a pus producer, but is productive of lesions that are favorable for other infections.

The infectious agents that produce renal suppuration may reach the organ either through the blood (hematogenous infection) or through the lymph (lymphogenous infection), or they may reach the organ by extension of the suppuration from neighboring structures (infection by contiguity), and finally the infection may travel upward from some lower portion of the genito-urinary tract, as the urethra or bladder (ascending infection, or infection by continuity.

The ureteral, lymphogenous and hematogenous routes of these infections have been carefully investigated by Albarran and others of the Necker school, who have concluded that the circulatory is the most common. Pus-producing microörganisms in the blood current circulating through the kidney or its pelvis are not likely to give rise to suppuration without the presence of congestion due to some of the predisposing causes just mentioned; but if congestion is present, the germs, having passed through the circulation and entered the urinary tract, find the pelvis a soil adapted for their settlement and growth.

We have, therefore, covered the causes of this group of diseases in a general way, and those of pyelitis in particular.

Pathology.—Pyelitis usually begins with a simple catarrhal condition of the mucous membrane of the pelvis, with congestion of the superficial capillaries and an excess of mucus. As infection takes place, the mucous membrane takes on the appearance of a turbid gelatinous lining, which is rapidly followed by a purulent exudate and thickening of the wall. The thickening and roughness of the pelvic wall are more marked in tubercular cases and the ulcerations are of a more active type. There is also great thickening at times in calculous pyelitis, as well as erosions and capillary hemorrhage.

When the pyelitis is due to an ascending infection, there is a greater dilatation of the pelvis, its surface is smoother and thinner and the capillary congestion is less. The amount of urine and pus is considerable and the admixture thinner than in the descending cases. Capillary congestion, engorgement, erosions and ulcerations are also less marked. It must be remembered that urinary retention takes place in varying degrees when there is obstruction due to tubercular lesions or calculus, but that the retention is greater when there is obstruction due to interference with the urinary flow in the ureter proper.

When the pyelitis advances to such a degree that there is retention of urine and pus in the renal pelvis, the parenchyma is also generally involved and the trouble becomes a pyelo-nephritis or pyonephrosis.

Symptoms.—The symptoms of pyelitis are few and at times absent when it exists alone and not associated with calculus, tumor, tuberculosis or abnormal renal mobility. There is sometimes slight frequency of urination, due to a polyuria, or there may be a vague pain or a heavy feeling in one or both loins. The pain is more intense and colicky when the pyelitis is due to calculus or to movable kidney. Hematuria is rare in pyelitis unless there is a growth or stone present, when it is common; whereas, in tuberculosis it is still less frequent. Pyuria exists, but is of a mild degree when the pelvis is alone involved; but when a cystitis also is present, the pyuria is more marked, owing to the addition of the pus produced in the bladder to that coming from the pelvis and ureter. Marked frequency of urination is due to an associated cystitis, probably tubercular. Attacks of nausea, vomiting, chills, fever and sweating are generally due to movable kidney or renal calculus, with attacks of retention and absorption of pus. Febrile attacks also point to an extension of the inflammation to the kidney substance and we must, therefore, always be on our guard against such an involvement.

Examination.—In palpating the kidney in pyelitis, a slight tenderness may be experienced by the patient. There is usually no rise of temperature. There is no enlargement of the organ unless a complication is present, such as retention of urine and pus in the pelvis, or an extension to the kidney parenchyma.

The urinary examination shows in the chronic cases, such as are usually ob-

served, a urine of low specific gravity, somewhat increased in amount, containing considerable pus, serum and nuclear albumin, pelvic epithelia and a few blood cells and hyaline and granular casts. In case the disease is due to tuberculosis, the bacilli may be found in the urine; while if due to stone, crystals may be found in masses of pus and mucus, and the specific gravity is higher.

Diagnosis.—In the differentiation of pyelitis and cystitis, there are some rather interesting points. In chronic cystitis, the daily amount of urine and urea are always normal, unless the patient has been given a large amount of water or diuretics. The reaction is generally alkaline, or if not, it soon becomes so, unless due to the colon or tubercle bacillus. The amount of albumin does not exceed that caused by the pus and blood. There is a muco-purulent sediment which coagulates quickly. Microscopically, pus and a large number of bladder epithelial cells are found in the urine. The large amount of epithelium that is present is striking, rather than any particular type. There is no renal pain, nor tenderness on pressure over the kidney.

In chronic pyelitis, there is polyuria, the sediment is more diffuse and does not coagulate, or certainly not so quickly. The urine is usually acid in reaction and contains but few epithelial cells. The importance of the colon bacillus is not sufficiently appreciated; it is very frequent and its recognition is not difficult. A cystoscopic examination will always give information concerning the condition of the bladder.

Prognosis.—The prognosis of pyelitis depends entirely upon its cause and the presence of associated lesions. If the cause is removed, the patient should recover. This may require some time, or it may never take place, in which latter instance the pyelitis would probably slowly extend up into the kidney and develop into a pyelo-nephritis or a pyonephrosis. In many cases, the kidney is involved together with its pelvis, but the condition is not recognized.

PYELO-NEPHRITIS

Etiology.—The etiology of pyelo-nephritis is the same as that of pyelitis, as it is either an extension from the pelvis up the straight tubules of the kidney, which is especially the case in obstructive conditions; or from above downward, as in tuberculosis, which almost always begins in the renal parenchyma and descends to the pelvis. In saying that suppurative nephritis is secondary to a suppurative pyelitis, I do not necessarily mean that the infection must come from below up through the ureter and pelvis, as there may be a congestion or nonsuppurative nephritis that develops during a pyelitis which later becomes a septic nephritis, due to microörganisms brought to the kidney through the circulation and then entering the urinary tract.

The involvement of the kidney in pyelo-nephritis was formerly believed to be invariably due to an ascending infection, especially after traumatism of the

urethra, prostate or bladder in passing instruments for the sake of examination or treatment of a patient. It is evident, however, that in the event of erosions due to traumatism in passing an instrument, absorption of the pus may occur from that part of the urinary tract where the lesion is situated, and the infection travel through the circulation to the kidney. In fact, in cases in which the predisposing causes to pyelo-nephritis exist, either as obstruction or irritation from whatsoever cause, pus-producing germs, taken into the circulation from any suppurative focus in the interior or on the exterior of the body, can be carried through the circulation to the kidney and cause pyelo-nephritis.

Pathology.—The disease is usually bilateral, when due to obstruction in the bladder, prostate, or urethra, but the kidneys are generally not equally involved; whereas, in cases due to obstruction of a single ureter or renal pelvis, the trouble is unilateral. As far as the renal pelvis is concerned, the pathology of pyelo-nephritis is similar to that of pyelitis. In the kidney, however, the process is usually that of a diffuse nephritis plus pus. In other words, the parenchyma of the organ, consisting of the tubules and the glomeruli, is involved to a greater or less extent, and the interstitial tissue as well. The kidney is enlarged in most cases, the size depending upon the amount of inflammation, abscess formation and exudate about the abscesses and their cavities, and also on the dilatation of the pelvis. The changes in the parenchyma are for the most part moderate, although there may be areas where it is very much involved. In certain localities, there are greater inflammatory thickenings of the parenchyma than in others, and here abscesses are more liable to develop, which usually break into the pelvis of the organ.

Fig. 281.—Pyelo-nephritis.

Numerous abscesses may be found in the kidney in pyelo-nephritis, varying in size from that of a pea to a marble. They are more frequent in cases of

tuberculosis, in which cases the disease is often very acute. Abscesses are also frequent in some cases due to stricture and enlarged prostate. It must not be thought, however, that, in stricture and enlarged prostate, the pyelo-nephritis is not as acute as in tuberculosis, for in these conditions one or more abscesses may be even larger than those in tubercular infection of the kidney (Fig. 281). Large abscesses also occur in calculous pyelo-nephritis.

Having made a section through the convexity, the pelvis is seen to be thickened and congested in areas; there may be some erosions or superficial ulcerations, and the surface is covered with pus, the same as has been described under Pyelitis. The pyramids of the kidney are streaked yellow and red. The yellow streaks may also be seen radiating from the pyramids into the cortex, which constitute a feature of suppurative pyelo-nephritis. The cortex and medullary portion are indurated in places and one or more abscesses may be seen there.

On squeezing the kidney, pus and urine may be expressed from the collecting tubules into the calices. Large areas of kidney tissue are sometimes found to be completely destroyed, occasionally an entire pole in advanced cases.

The microscopic lesions of suppurative pyelo-nephritis are, in the order of their sequence, an exudation of leucocytes into the renal tubules and around the glomeruli; a diffuse purulent infiltration of the parenchyma with gradual destruction of the epithelium; an increase in the connective tissue of the stroma, which takes part in the process of destruction; and finally, infiltration and gradual destruction of the connective tissue in places, resulting in the formation of cavities filled with pus. The suppurative process may involve the adipose capsule and may be complicated with perinephritis.

Symptoms.—In many cases of mild pyelo-nephritis, there may be no subjective symptoms, except a feeling of weakness, malaise and a dull pain or heavy sensation in the loin; while in more marked or more advanced cases, the symptom complex is a combination of the signs of uremia and septicemia. Some of the symptoms in chronic cases are referable to the gastro-intestinal tract. An acute attack usually sets in abruptly with chills. Pain is complained of in many cases of pyelo-nephritis and, while usually of a dull character, may, in the presence of a stone or undue mobility, be very severe, or associated with colics.

Colics also occur in tuberculosis, but these are of a milder character. When there are abscesses, however, the pain may be very acute and the muscular rigidity marked. The most marked pain, independent of colic, that I have ever seen in pyelo-nephritis, was in a case of tubercular kidney with abscess formation. The patients usually have some elevation of temperature. If the drainage is good, the temperature may be very slight—99° or 99.5° F.—but when pus is forming or has formed and there is obstruction to its drainage, the patient may have chills, a rise of temperature to 105° or 106° F., sweating

and symptoms of the most acute sepsis. The highest temperatures that I have seen have been in connection with stricture, prostatic hypertrophy and tuberculosis. When the abscess has broken into the pelvis and discharged through the ureter, as is usually the case, the temperature falls again, and if present, it continues in such a mild degree that it may not be noticed by the patient. An abscess in pyelo-nephritis may break through the capsule of the kidney, giving rise to a perinephritic abscess, which we will consider later.

The general symptoms of chronic pyelo-nephritis may be summarized as mildly uremic and septic, associated with cachexia, which gradually supervenes, as in all slow suppurative diseases.

Examination.—Palpation generally shows a kidney which is tender on pressure and enlarged to a varying degree. Sometimes marked muscular rigidity is present. The temperature and pulse are usually but slightly elevated, except when abscess formation or interference with drainage takes place, when it becomes so high as to endanger the life of the patient. In such cases, a chill may precede the rise of temperature. The fever is often compared with malaria, and many such patients enter the hospital with this diagnosis.

The urinary examination shows a turbid urine, yellow, amber and often the color of lemonade or starch water, of a specific gravity from 1.005 to 1.025, usually below normal. Sero-albumin and nucleo-albumin are present; the urea and chlorids are diminished. The microscopical examination shows many pus cells and pus in masses; a few red blood cells; sometimes crystals; epithelia from the pelvis and renal tubules; hyaline, granular, epithelial and pus casts. Pus casts are pathognomonic of a pus kidney. The finding of blood and crystals in the urine points to the presence of stone. The urine should also be examined for tubercle bacilli, and, if negative, guinea pigs should be inoculated. All patients, on whom the diagnosis of pyelo-nephritis has been made, should be radiographed as a matter of routine, and a diagnosis can never be considered complete unless this examination has been made.

Having examined the urine and having determined that pyelo-nephritis exists, it is necessary to make a thorough examination of the patient, as indicated in the chapter on Examination of the Kidney and also in the chapter on the Examination of the Patient, to determine if there is urethral stricture, an enlarged prostate, any abnormality of the bladder or ureter. The urine from each kidney should be taken and examined to discover if the other kidney is healthy or not, and its functional activity should be determined in case an operation is considered.

In cases of pyelo-nephritis in which the predisposing cause is an impediment due to stricture or prostatic hypertrophy, the inflammation may be the same on both sides, although it may vary in severity. In cases of pyelo-nephritis due to calculus or tuberculosis, either in the ureter or kidney, the disease is much more apt to be unilateral.

PYONEPHROSIS

Pyonephrosis is a suppurative condition of the kidney that follows a pyelitis or pyelo-nephritis. It is a pyelitis with an enlargement of the pelvic cavity, plus suppurative and atrophic changes in the substance of the kidney.

Etiology.—Pyonephrosis may follow a pyelitis, in which case there is usually some interference with the emptying of the pelvis, generally due to a renal calculus or to some obstruction or inflammation lower down in the urinary tract, the ureters, bladder, prostate (Fig. 282) or urethra.

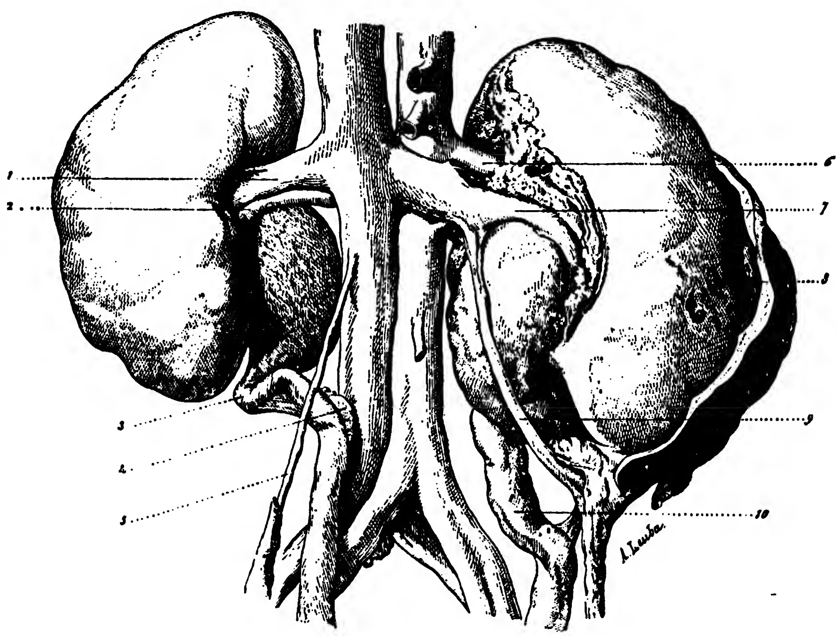


Fig. 282.—Pyonephrosis, showing Enlargement of the Kidneys and Their Pelves. Observe the kinked ureters.

Pyonephrosis may exist from the first as a pyelitis, in which case the pelvic cavity gradually dilates and the kidney substance is atrophied, or it may be secondary to a uronephrosis (hydronephrosis), which has become infected. In any case, as the pelvis increases in size, the parenchyma of the kidney is pressed upon and a diffuse, destructive, chronic nephritis, due to pressure, results, which is associated with suppurative changes in the renal substance.

Pyonephrosis may also result from a pyelo-nephritis, after part of the parenchyma of the organ has been destroyed by the suppurative process, owing to the formation and breaking down of the abscesses. Among the frequent causes mentioned in pyelitis and pyelo-nephritis as bringing on pyonephrosis, are stone and tuberculosis. A typical case of pyonephrosis developing from pyelo-nephritis with destruction of the kidney by abscesses may be seen resulting from tuberculosis.

Pathology.—The size of the kidney is generally increased and its color is lighter than normal. If a vertical incision is made through the kidney and its pelvis at the convexity, the pelvis will be seen to be dilated to a varying degree, with irregular arches extending upward toward the capsule, corresponding to the

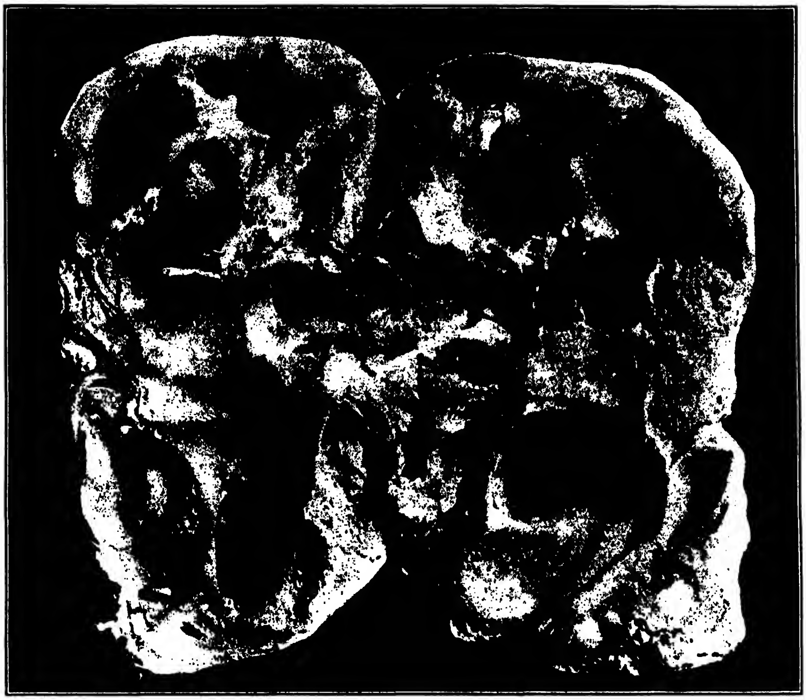


FIG. 283.—CROSS SECTION OF A PYONEPHROTIC KIDNEY, 7½ INCHES LONG. The kidney held a pint of pus.

calices, which communicate with the renal pelvis and with one another (Fig. 283). Opening into these arches, cavities may be seen that are the results of abscesses. The kidney substance in more advanced cases is irregularly atrophied and in conjunction with the renal capsule, sometimes resembles a shell divided into large arches by bands corresponding to the columns of Bertini. There may be thick pus; or urine, detritus and pus mixed—of a white color in the pelvis. The inner wall of the sac is thickened and roughened, and erosions may be seen. The thickening is particularly marked in cases in which a calculus has been the cause of the trouble. In tubercular cases also the walls are rough and infiltrated in a varying degree. Areas of thickening are found also in the ureters in tuberculosis, stricturing them and causing the obstruction that brings about the pyonephrosis.

Symptoms.—Pain is not so marked as in pyelo-nephritis. It is of variable severity and sometimes altogether absent. The pain is generally most acute in cases of renal calculus or movable kidney, in which the ureter becomes blocked

or kinked and the organ is suddenly distended with pus and urine. It may also radiate down the ureter in stone cases. The patient has considerable distress and often nausea and vomiting when the kidney is distended. There is marked pyuria when the organ is draining well, and slight or no fever; but when the drainage is blocked, there may be a chill and a rise of temperature to 103° or 104° F. which drops as soon as the drainage is reëstablished. It is most common in calculous cases.

Examination.—Examination usually shows a large kidney, palpable to a varying degree and best detected by ballottement. This is especially the case when the pelvis is distended with pus. Large pyonephrotic kidneys often cannot be outlined, however, as their walls collapse when pressure is made. Tenderness is not as common as in pyelo-nephritis, but it is present when the sac is very much distended.

The urine is lighter in color than in pyelo-nephritis, often having a milky, starchy, or lemonade color. It is of lower specific gravity, and contains albumin, a diminished amount of urea and chlorids, granular, epithelial, pus and mixed casts, pelvic and renal epithelia, a few red blood cells, many pus cells and pus in masses. In tubercular cases, the bacilli are found, and in cases due to calculus, crystals may be found.

The urine varies in amount and appearance when the disease is on one side and due to stone. It is turbid when secreted from both kidneys, but may be clear and scant when coming from a healthy kidney during an attack of retention in the pelvis of the diseased organ.

Pyonephrosis is a more chronic process than is pyelo-nephritis. It sometimes happens that we have an acute pyelo-nephritis on one side and a chronic pyonephrosis on the other. In this case, there may be no pain on the side of the pyonephrosis, even when the organ is nearly destroyed. On the side of the acute pyelo-nephritis, there may be a large amount of functionating renal tissue, and nearly all the elimination may take place from that organ; and yet muscular rigidity, pain and tenderness are present and all subjective symptoms point to it as the principally affected kidney. Catheterization of the ureters shows the difference between the two organs, as the urine coming from the pyonephrotic side on which there are no symptoms would show a considerable amount of thin fluid resembling pus and water mixed, containing but a small amount of solids; whereas, on the side on which the acute symptoms are present, the urine might be comparatively normal in color and would contain a greater amount of solids, as well as the products of inflammation.

Diagnosis.—The diagnosis of pyonephrosis depends on finding a urine having the turbid or starch-water appearance, and finding that it contains albumin, pus, renal epithelia and various kinds of casts, including pus casts. Then, on catheterizing the ureters, it will be seen that the elements of kidney disease found in the general urine can be accounted for by the urine coming from the

suspected kidney. A considerable amount of urine from the diseased kidney may run out as soon as the catheter is introduced into its pelvis, perhaps half an ounce or more, which, on examination, will be found to consist principally of a clear fluid with but a small amount of solids, albumin, considerable pus and other pathological kidney elements.

In both pyelitis and pyelo-nephritis, the urine is generally of a higher specific gravity than in pyonephrosis and would contain more solids. Pyuria is more marked in pyonephrosis than in either pyelitis or pyelo-nephritis.

The diagnosis of the cause of the pyonephrosis is more difficult and includes all the various steps that have been included in the chapter on Examination of the Kidney.

Treatment of Pyelitis, Pyelo-nephritis and Pyonephrosis

In case of *pyelitis*, as soon as the diagnosis has been made and even before the cause has been determined, it is advisable to have the patient drink a considerable amount of water, say two quarts a day, to flush the kidneys, and to give three times a day an internal urinary antiseptic, such as urotropin, 10 grains; benzoate of soda, 15 grains; benzoic acid, 15 grains; salol, 5 grains, or other urinary antiseptics. Lavage and injections of the renal pelvis by means of ureteral catheters have been practiced for many years and have been advocated especially in cases of gonorrheal pyelitis, which condition has been extremely rare in my practice. For several years, lavage and injections of the pelvis through the ureteral catheters have been employed quite extensively by us in the cystoscopic room of the clinic, and several thousand lavages and injections have been made. Most of these cases had but slight symptoms and discontinued their visits on account of the inconvenience the treatment occasioned them. In one case of gonorrheal pyelitis, due to gonorrheal infection, the pelvic lavage and injections with solution of nitrate of silver and its derivatives were kept up constantly for two years, but the gonococci were still present at the last examination and the patient was no better; if anything, he was worse. So far, covering a period of nine years that cases of pyelitis have been treated by lavage of the renal pelvis, there is not a history of a single case that has been cured by this method. The solutions used were a silver nitrate, 1 : 4,000 to 1 : 2,000 or milder, alone or combined with boracic acid; protargol, one half to two per cent in strength; argyrol, ten- to twenty-five-per-cent solution; and 1 : 5,000 solution of formalin. But few patients seem to have been relieved by such treatment. Some of these patients have had injections of the renal pelvis more than a hundred times and did not improve. Injections of silver solution and protargol seem to have been the most effective, and doubtless many who have been treated at the clinic recovered later.

Pyelitis without a predisposing cause is an extremely rare condition, if it ever exists, and patients suffering from it should never be subjected to such

local treatment until the physician has discovered the cause and considers pelvic injections indicated. Otherwise, he might inject the pelvis of a tubercular kidney, in which case the passing of a catheter might aggravate the condition and also provoke tubercular lesions in the ureter through catheter traumatism.

The surgical treatment of *chronic pyelitis* consists in the removal of the cause. Sometimes, in pyelitis due to obstruction which may exist anywhere from the cavity of the pelvis itself to the external urethral meatus, it may be easy to locate the cause. These obstructions are usually urethral stricture, prostatic hypertrophy, vesical tumor, stone in the ureter, or pressure by growths or adhesions outside of the ureter; or stone or growth in the pelvis of the kidney. In such cases, the obstruction should be overcome as follows: Urethral strictures should be dilated or cut; hypertrophic prostates should be subjected to catheter life or prostatectomy; vesical calculi should be crushed or removed by suprapubic cystotomy; vesical tumors should be excised through a suprapubic incision or fulgurated; stone in the ureter should be removed by ureterotomy; ureteral stricture should be dilated or ureterorrhaphy or plastic operations performed; adhesions about the ureter should be broken up and the canal stretched out; growths pressing upon the ureter should be removed; a renal calculus should be removed by nephrolithotomy; obstruction in the pelvic wall should be treated by plastic operations; while in cases of tumor of the pelvis, the entire organ should be removed (nephrectomy). (See chapters on Operative Surgery of the Renal Pelvis and Ureter.)

The treatment of *pyelo-nephritis* is either palliative, expectant, or radical, depending upon the symptoms. In case a patient has a chill, followed by a fever, and examination shows tenderness and perhaps a noticeable enlargement of one kidney, it does not necessarily mean that this kidney will develop an abscess that will require immediate operation, for the symptoms often subside with rest in bed, milk diet, diuresis and urotropin. It is also advisable to cup the patient over the kidney, to keep the bowels open and to give quinin, three grains, three times a day. If the temperature continues high and assumes a septic curve, a nephrotomy should be performed and the kidney drained, although probably, if no operation were performed, the abscess would rupture into the renal pelvis. If the nephrotomy shows the kidney to be extensively diseased and a condition of chronic sepsis which is injuring the patient's health continues after the operation, a secondary nephrectomy should be performed, provided the other kidney is sufficiently healthy to carry on the renal function. A tubercular kidney in a state of pyelo-nephritis should always be removed in case the other kidney is capable of carrying on the work. In calculus pyelo-nephritis, nephrolithotomy should be performed, nephrectomy being reserved for those cases in which the renal tissue is almost entirely destroyed.

A pyelo-nephritis of any variety may break down and empty into the pelvis

until the kidney tissue is extensively destroyed, causing an extensive reno-pelvic cavity, pyonephrosis; or an abscess may break through the capsula propria, giving rise to a perinephritic abscess.

Cases of pyelo-nephritis not due to obstruction, tumor, or calculus, sometimes, under favorable conditions, undergo a change for the better in any stage of the disease, the involved areas break down and are cast off in the urine, or else they develop into fibrous tissue. This occurs in tubercular cases oftener than is generally supposed. In cases due to obstruction and stone, however, the obstacles must be removed before the destructive process in the kidney is arrested.

In the treatment of *pyonephrosis,* it may be said that a pyonephrotic kidney can always be removed if the other kidney is able to keep up the work of elimination necessary, and it is recommended, if the kidney tissue is very much destroyed. In cases of nephrolithiasis and pyonephrosis, I prefer to remove the stone by nephrotomy and drain the kidney with the object of seeing if the fistula, which usually follows, will close, and if some functionating renal tissue will remain; and then in case the kidney is found later to have no power of elimination, to perform a secondary nephrectomy. Pyonephrotic kidneys occur in renal tuberculosis as well as do pyelo-nephritic and should be removed if the other kidney is sufficiently healthy. Pyonephrotic kidneys due to any trouble may be entirely destroyed and remain as atrophic, nonfunctionating shells, or masses of fibrous tissue. Calculous pyonephrosis may act in the same way after removal of the stone by nephrotomy. A pyonephrotic kidney may undergo rupture, giving rise to a perinephritic abscess. In one case of perinephritic abscess, I found a renal calculus lying outside the kidney, which was but a mass of fibrous tissue surrounded by suppuration.

When the patient is in such poor general condition that any operation is contraindicated, the treatment must be expectant or palliative and it is then the same as the conservative treatment of pyelitis and pyelo-nephritis.

Personally, I am inclined to believe that the literature of suppurative diseases of the kidney is still governed by that of the past and will be greatly changed in the next few years. I think that formerly many cases of pyelo-nephritis and pyonephrosis were called pyelitis; also that many cases of pyelitis with but few symptoms of pain, or else pain of a dull character, were due to stone. Many other cases were probably due to tuberculosis, in which not much renal enlargement was found and the tubercle bacilli were not discovered. As the date of the literature of pyelitis dates back much farther than that of such up-to-date methods of renal diagnosis, as radiography in renal calculus and the detection of the tubercle bacilli by the microscope and by the injection of guinea pigs, it is easy to see how many cases of these suppurative diseases of the type mentioned in the literature might have been due to these causes. Again with the thorough training in surgery that the students of the medical schools now have, the obstructive lesions of the urinary tract, which are the principal causes

of these troubles, will be better understood and attended to before the renal suppuration has taken place.

More study of these diseases should be made by those interested in renal surgery to make this involved subject more comprehensive to the practitioner.

PERINEPHRITIC ABSCESS

A perinephritic abscess is a collection of pus about the kidney, usually situated between that organ and the posterior abdominal wall. It is unilateral in about ninety-nine per cent of the cases and is more common on the right side.

Etiology.—Generally, cases are called primary which originate in the perinephritic tissues *per se*, and secondary when due to the extension of infection from the kidneys or other organs or tissues. Primary abscess has been attributed to traumatism, blows, exertion and congestion from heat or cold. Personally, I do not believe that any one of these primary causes is sufficient to produce a perinephritic abscess, except when the traumatism opens the perinephritic tissue and carries in infection, as in the case of a stab or gunshot wound. I believe, however, that the blows and exertion are the active cause of the trouble when a suppurative focus is present in the kidney or some other organ or tissue. I think that a better classification would be, *primary*, when due to a suppurative process in the kidney, and *secondary*, when due to a suppurative process elsewhere.

I further believe that seventy-five per cent of the cases originate in the kidney. In an address that I delivered before the Chicago Medical Association in 1905, I stated that I believed that nearly all cases were due to renal disease and that those secondary to disease of other organs are rare and not, properly speaking, perinephritic abscesses. These deductions were based on a study of fifteen consecutive cases, in which renal suppuration existed in fourteen. I will here quote the statistics of the cases:—

Renal calculus	4
Renal tuberculosis	4
Pyonephrosis	3
Pyelo-nephritis	2
Rupture of kidney	1
Empyema	1

Since then, I have had five more cases that I can recall, three of which were due to tuberculosis, one to necrosis of the rib and the other one I could not account for. This would change the statistics in my last twenty consecutive cases, which I will consider under the names of the diseases:—

Pyonephrosis	Calculous	3		
	Tuberculous	5		
	Obstructive	3		
Total			11	
Pyelo-nephritis	Calculous	1		
	Tuberculous	2		
	Obstructive	2		
Total			5	
Rupture of kidney		1		
Empyema		1		
Necrosis of rib		1		
Unknown cause, probably suppurative retroperitoneal gland		1		
Total			4	
Full total				20

This makes the statistics eighty-five per cent due to renal trouble, which differs from the statistics of former writers and depends on a careful analysis of catheterized specimens of urine taken from each kidney, as well as an inspection of the kidney at the time of the first operation or shortly afterwards.

Cases of secondary perinephritic abscess result from the extension of a suppurative process from other organs or tissues, either in the abdominal, pelvic or the thoracic cavity. When secondary to disease of an organ in the abdomino-pelvic cavity, if the organ at the site of the suppuration is not covered by peritoneum, the pus can extend or burrow beneath or behind the peritoneum until it reaches the perirenal tissues. If the organ at the site of the suppuration is covered by peritoneum, the apposing surfaces of visceral and parietal peritoneum must first adhere before the suppurative process can pierce the two layers and reach the perirenal fossa.

Among the conditions in the abdomino-pelvic cavity which may give rise to perinephritic abscess, the following may be mentioned: Abscess of the liver, suppurative cholecystitis, abscess of the spleen or pancreas, typhoid fever, appendicitis, ulcerative colitis, operations or diseases of the rectum, impaction of feces with ulceration, prostatic abscess, diseases or injuries of or operations on the urethra, the spermatic cord or the testes, diseases of or operations on the uterus and adnexa. Next follow the conditions in the thoracic cavity that may give rise to perinephritic abscess, which are abscess of the lungs and empyema. In these cases, the suppurative process extends through the pleura and diaphragm into the perirenal space. The disease is more common than is generally supposed.

Symptoms and Diagnosis.—The diagnosis of perinephritic abscess *per se* is not usually difficult; but the discovery of the sources is often not only difficult but impossible. The onset of the trouble is the same as that of any other deep-seated abscess: septic fever, sweating, perhaps, ushered in with a chill or chilly sensation. The grade of fever varies in different cases, depending upon the amount of leakage into the perirenal space and the character of the infection. The other general symptoms are loss of appetite, strength and weight, headache, coated tongue, nausea, flatulence and constipation. The local symptoms begin with a feeling of fullness, or a dull deep-seated pain in the space under the twelfth rib, which becomes worse on deep inspiration. Pain in any other region than the loin in such cases may mean a referred pain, or that the abscess has burrowed away from the loin behind the peritoneum to other parts, or that the region in which the pain is most marked is the source of the abscess. The pain may at times be paroxysmal in character and may be attributed to various directions as the hypogastrium, groin, testis or even to the knee, owing to the wide distribution of the lumbar plexus. This occurs principally in cases that are due to renal calculus.

Examination.—The *temperature* may run from 99° to 100° F. or from 103° to 105° F., the usual grade being from 99° to 102° F. The *pulse* in perinephritic abscess is often rapid at first, full and hard, while later it will be found to be small, rapid and weak, as the sepsis increases. The skin is usually hot and dry, or covered with profuse perspiration.

FIG. 284.—BULGE IN PERINEPHRITIC ABSCESS IN LEFT SIDE OF LOIN. Front view. (Author's case.)

The *position* of the patient is often quite characteristic. When he lies on his back, the thigh on that side will not extend beyond the angle of 160° to 180°. In walking, he shows more or less stiffness and inclines the body to the affected side. Some cases, however, fail to show any of these signs.

There is tenderness on pressure in the loin, as well as in the abdomen. In some cases, there is a tumor or swelling noted on one side on inspection, the lumbar hollow being replaced by a slight bulge of the tissues under the ribs. This difference is chiefly noted when the patient is sitting or standing and may be overlooked when he is recumbent. Gradually the ileo-costal curve is obliterated, as in Figs. 284 and 285. The lumbar tumor often does not appear until

weeks after the onset of the suppuration. Such a slow process is usually associated with a case of tubercular kidney in which the capsula propria and the external capsule have become adherent, and the abscess is walled off as it extends. The sudden rupture of a large abscess of the kidney into the perirenal space, in a case in which there has been no or but a slight walling-off process, often results in a very acute onset and a rapid development of pus and tumor.

FIG. 285.—CHARACTERISTIC BULGE IN A PERINEPHRITIC ABSCESS ON THE LEFT SIDE. Back view. (Author's case.)

On *palpation* a diffuse tumor is felt principally in the back part, which does not have the outline of a kidney and cannot be ballotted.

There is sometimes dullness on *percussion*, especially if the abscess is superficial. On the right side, the dullness is continuous with that of the liver behind, while on the left, it is continuous with that of the spleen. Fluctuation is sometimes present early in the course of the disease; more often it appears later, but usually not at all. Redness of the surface is rarely noticed, as the abscess is below the deep fascias. I have had one case in which three quarts of pus were present and yet there were neither redness nor fluctuation.

The last steps of the diagnosis depend on a puncture or an incision.

Diagnosis for the Source of the Abscess.—Having made a diagnosis of perinephritic abscess, an attempt should be made in every case to discover the source of the suppuration. In the first place a careful history should be taken to find out from what diseases the patient has suffered recently, whether he or she has

had any injury of the abdominal or thoracic cavity, or whether an operation has been performed in these regions. If such is found to be the case, the point of the inflammation, injury or operation is the one which should be looked to as the source of the abscess.

If there is no such history, a systematic examination should be resorted to. The urine should be carefully examined for evidence of kidney disease. If pus is found in the urine, we should endeavor to determine whether it comes from the kidney, and if so, we should determine by ureteral catheterization whether it comes from the kidney of the affected side. It must be remembered, however, that a perinephritic abscess may be secondary to an abscess of the kidney, even if no pus is found in the urine, as in Fig. 286, which resulted from a tubercular cortical abscess. It did not communicate with the pelvis. Generally, however, there is a suppurative process connected with the kidney pelvis, and pus will be found in the urine (Figs. 287 and 288).

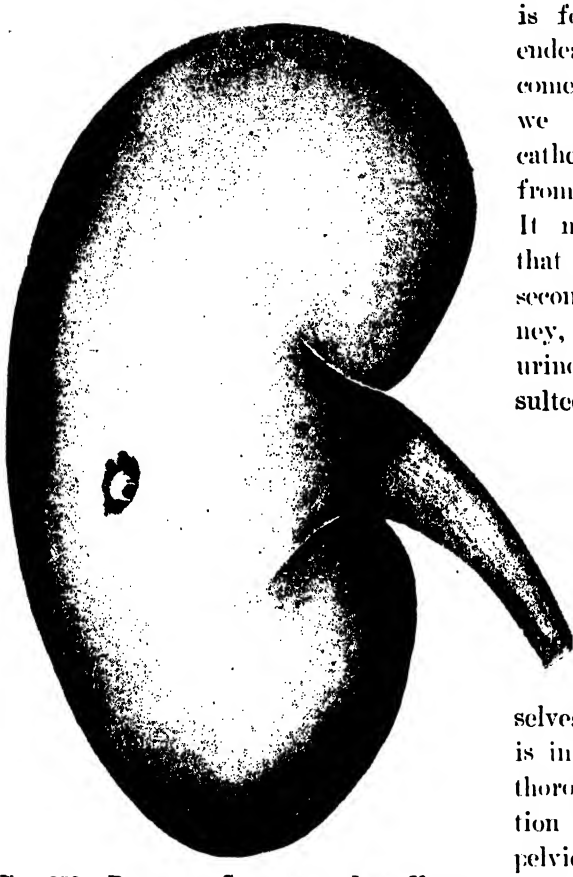


FIG. 286.—POSTERIOR SURFACE OF LEFT KIDNEY IN A CASE OF PERINEPHRITIC ABSCESS. Shows opening of a cortical tubercular abscess which communicated with the perinephritic cellular tissues. (Author's case.)

If we cannot satisfy ourselves that the source of the trouble is in the kidney, we should make a thorough and systematic examination of the organs in the abdomino pelvic and thoracic cavities. In making this examination, we should have in mind the various conditions that may give rise to perinephritic abscess, mentioned under Causes.

It must be remembered that, when we find a perinephritic abscess that has existed for some time, and there is pus in some other neighboring localities, it is difficult to say whether the pus came from the other point and settled in the perirenal space, or extended from the perirenal space to these localities, or simply accumulated in this space as a depot while traveling from one point to another.

It should also be borne in mind that, after opening the abscess and washing

it out, the finger should palpate carefully the entire region for openings, however small, in the surface of the kidney or adjacent structures, or for sinuses running up to more distant tissues. All such openings should be probed and examined with an electric light thrown into the cavity. In the case of the

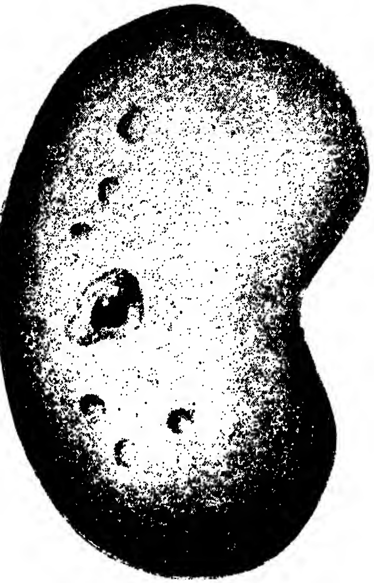


FIG. 287.—POSTERIOR SURFACE OF TUBERCULOUS KIDNEY IN A CASE OF PERINEPHRITIC ABSCESS. The organ was 4 inches long. Note the opening on its surface. (Author's case.)

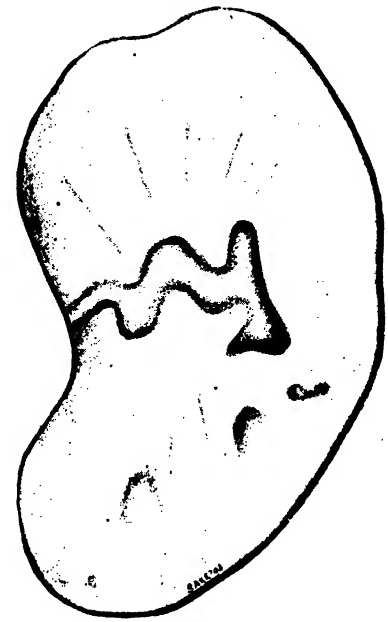


FIG. 288.—LONGITUDINAL SECTION OF SAME KIDNEY, SHOWING CONTRACTED PELVIS NOW NOT MUCH LARGER THAN THE URETER. The renal fistula extends from the pelvis to the point where it has broken through the capsule of the kidney as a perinephritic abscess. (Author's case.)

tubercular cortical abscess, just referred to, the tip of the finger could just be inserted into the abscess cavity in the kidney. There was no pus in the urine. The patient developed shortly after this a tuberculous knee, requiring excision, and thus confirming the clinical diagnosis of a preceding tuberculous abscess.

The Course of the Abscess.—The course of the abscess varies. In the first place, it may be absorbed after being walled off by connective tissue. I have had one such case in which all the symptoms gradually subsided. Again, it may extend through Petit's triangle and rupture externally. Very few abscesses rupture externally or into the intestinal or urinary tract; but the patients die of a slow sepsis unless operated upon. The abscess may break into the pleural cavity or lungs, in which latter case it is coughed up and the patient may recover, although usually he dies of sepsis unless the pleural cavity and the perinephritic space are both opened. Rupture into the peritoneal cavity is followed by septic peritonitis and death.

When the abscess burrows along the psoas, it gives the symptoms of psoas abscess. The tumor is felt as a fluctuating mass at or below Poupart's ligament, and may extend down the thigh. Fig. 289 shows the point of bulging of a perinephritic abscess just above Poupart's ligament and the point (A) at which it was opened in the inner side of the thigh. It may extend to the pelvis and break into the gut or urinary tract, or through the sacrosciatic foramen into the sciatic region, beneath the gluteal muscles or on the back of the thigh. When perinephritic abscesses break externally, it is usually in the in; next in frequency, the pleura and bronchi; and after this, the intestine.

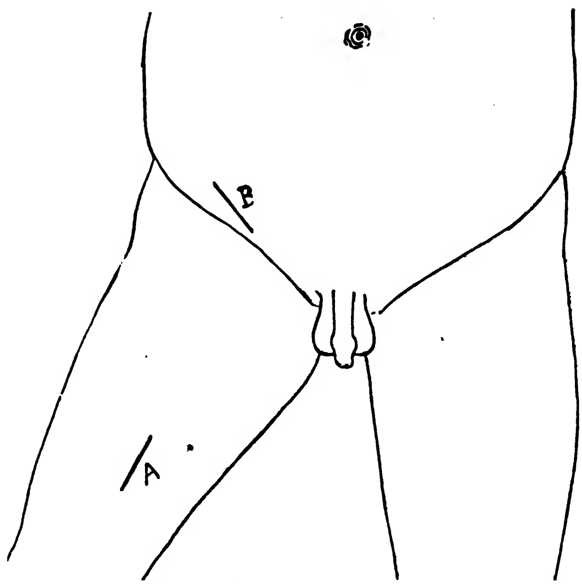


Fig. 289.—A Bulging of Pus in the Groin and an Opening in the Thigh Made to Drain a Perinephritic Abscess that Had Burrowed Down from the Renal Fossa. (Author's case.)

Treatment of Perinephritic Abscess.—As soon as the diagnosis of perinephritic abscess is ascertained, a lumbar incision should be made into the perirenal space to allow the escape of pus, after which the cavity is washed out with salt solution and then with peroxid and again with salt solution. The abscess cavity should then be explored with the finger. It is often surprising to note how extensive such a cavity may be, the fingers going up to the diaphragm and down into the iliac fossa, or even into the pelvis. In cases in which a pyonephrotic kidney has ruptured, the fingers may find themselves in the pelvis of the kidney. It is very difficult for anyone, who has not an experienced touch, to open a lumbar abscess and ascertain the exact source of the pus. For this reason, the kidney should always be palpated carefully to see if there is an opening into it, or if the organ feels pathological. If an opening is found, the finger should be inserted, and in case it enters the pelvis, the cavity should be palpated to discover if calculi are present. In that case, they should be removed. If there is an opening in the kidney that will not admit the finger, a cigarette drain should be inserted down to it and the incision closed, with the idea of opening it again in a few days, when the patient is better able to stand the operation, or when the tissues have again resumed their normal relations. In some cases, the kidney is so pushed to one side that it cannot be located at the time of the first operation and it will be necessary to explore it later.

During these secondary, exploratory operations, the kidney can be more carefully examined and an exploratory or drainage nephrotomy performed, or a nephrectomy, as decided upon by existing conditions. In four cases in which a perinephritic abscess was due to a calculus, in one case the calculus had been discharged from the kidney with the pus when it ruptured. (See chapter on Renal Calculus.) In another case, the stone was felt protruding from the kidney like a spur and was pulled out (Fig. 290). In still another, there was a small sinus in the kidney and the stone was not discovered until an exploratory nephrotomy had been performed. In another instance, I could not find the stone at nephrotomy and it was not until later after a nephrectomy had been performed that the calculus was discovered in a pocket. In all my operations on tuberculous kidneys, with one exception, the opening into the kidney communicated directly with the pelvis.

In the case in which the abscess burrowed down beneath Poupart's ligament, it was opened in the inner part of the thigh (see Fig. 289).

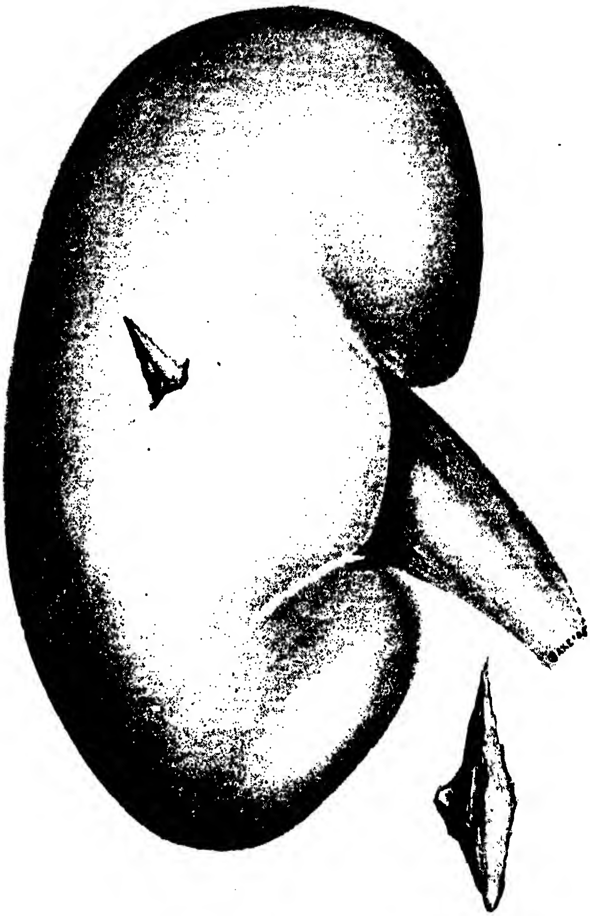


Fig. 290.—A Sharp-pointed Calculus that Was Found Sticking through the Wall of the Kidney in a Case of Perinephritis. (Author's case.)

ABSCESS OF THE KIDNEY

There are several forms of abscess of the kidney: (1) Those associated with renal tuberculosis; (2) those associated with stone; (3) those associated with obstruction of the urinary flow in the pelvis of the kidney or in the urinary tract below it, coupled with an existing infection in the urinary tract; (4) those in which the abscesses form in the kidney substance, independent of infection of the renal pelvis, that is, it may or may not be infected.

Groups 1, 2 and 3 have been discussed in the foregoing part of the chapter under Pyelitis, Pyelo-nephritis and Pyonephrosis, and we have recognized the fact that the course of the affection may be ascending or descending and that the predisposing cause is generally some obstruction or irritation in the renal pelvis or below, that favors congestion in the kidney, and a diminished resistance. If an abscess develops in the kidney substance proper, the infection may be derived from any part of the body; but it is usually due to infection in the lower urinary tract.

Group 4, in which abscesses form in the renal substance independent of infection in the renal pelvis, is the condition that will now be considered. In these cases, however, the same causes that favor renal suppuration exist; namely, some obstruction in the renal pelvis or below, that interferes with the flow of urine and causes renal congestion and consequent diminished resistance on the part of the kidney. An existing nonsuppurative nephritis, together with a diminished resistance, may also provide this predisposition.

These abscesses may then be considered primary, and, if their contents are discharged into the pelvis of the kidney, the condition of the pelvis favoring an infection, a pyelo-nephritis may result; or a pyonephrosis in case there is a large amount of destruction.

I will consider these abscesses of the kidney in Group 4 as primary abscesses. There are two varieties: The miliary (disseminated) and the circumscribed. They are of a hematogenous origin and pyemic in character, originating as septic infarcts.

The *miliary abscesses* may invade the entire kidney cortex or only a part of it; although, when they invade the entire kidney substance, they are much more marked in certain areas than in others.

The *circumscribed abscesses* may result from the breaking down of one or more areas of the miliary type into one large-sized abscess or into several; or they may develop as localized abscesses independent of the miliary type.

Etiology.—The predisposing causes of such kidney abscesses are, as already mentioned, anything that tends to produce congestion or to diminish the resistance of the kidney parenchyma, such as urethral stricture; prostatic hypertrophy, stone or tuberculosis of the prostate; stone or tumor of the bladder; stone, tumor, tuberculosis or kinking of the ureter; stone, tumor or dilatation of the pelvis of the kidney, with urinary retention; and stone, tumor, pathological mobility of the kidney and also parenchymatous or interstitial nephritis, or congestion due to infectious diseases.

The active cause is the introduction of pyogenic germs: The colon bacillus, Staphylococcus aureus, Streptococcus pyogenes, etc. These may come from any focus of suppuration in the body and cause diffuse miliary abscesses of the kidneys, resembling those of miliary abscesses in the lungs in septic pneumonia, that is, of a pyemic type. Such pus-producing germs enter the kidney and

lodge in the fine capillaries, forming innumerable small septic areas. They may come from appendicular abscesses, carbuncles, septic metritis or endometritis, septic endocarditis, septic phlebitis or many other septic conditions located anywhere in the system. The infectious diseases, by lodgment of the specific germs in the substance of the kidney, also provide an active infection in these cases.

Typical disseminated abscesses, varying from a pin point to a large pea, may also develop in very large numbers in patients who have a suppurative condition of the lower genital tract, bladder, prostate or urethra.

Fig. 291.—Multiple Disseminated Abscesses of Kidney. The kidney was 7¼ inches long. Nephrectomy. (Author's case.)

Pathology.—The kidney is swollen and increased in weight. In the disseminated form, the removal of the capsule exposes, in the cortex, numbers of protruding abscesses frequently surrounded by a hemorrhagic zone.

Individual abscesses generally do not exceed the size of a pea. Fig. 291 shows the cortex of the kidney to be riddled with abscesses varying in size from

a pin point to a pea. When grouped, which often is the case, the masses thus formed may occupy a much larger area, the size of a filbert (a circumscribed abscess). On incision of the abscesses (Figs. 292 and 293), a greenish-yellow pus exudes, in which, on microscopic examination, the pyogenic agent can be demonstrated. On section through the convexity of the kidney, the groups of cortical abscesses are found to occupy a wedge-shaped area, the apex directed toward the pelvis. The medulla is generally congested and traversed by perpendicular yellow lines which are continuous above with the wedge-shaped foci in the cortex. Microscopic examination shows areas of necrosis surrounded by dense, round-celled and polynuclear leucocytic infiltration; the tubules are filled with pus and bacteria and not infrequently also the intracapsular spaces and the Malpighian bodies. Circumscribed abscesses may reach a large size involving both the cortex and the medulla and may break into the renal pelvis or externally through the capsule, giving rise to a perinephritic abscess.

Symptoms.—The symptoms of miliary abscess of the kidney are mixed of sepsis and later uremia: Chills, fever, sweating, temperature from 100° to 105° F., pulse 90 to 120, headache, pain more or less marked in the loin, prostration, loss of appetite, perhaps nausea and vomiting, and later apathy, stupor, delirium, constituting a typhoid state, and occasionally convulsions.

Examination.—Upon examination, we find tenderness and perhaps muscular rigidity over one or both kidneys. The urine is scanty and shows at first a trace of albumin, a few pus cells, renal epithelia and occasional red blood cells and later casts. The blood shows no indications of typhoid fever or malaria, but signs of sepsis, e. g., a leucocytosis of from 10,000 to 30,000. Ureteral catheterization will usually show that the albumin and cells come from the kidney that is painful. These kidneys are often found to be enlarged on palpation. Brewer has shown that this type of disseminated miliary abscess is usually located in one kidney at the onset.

Treatment of Primary Abscess of the Kidney.—From my experience in the treatment of renal abscesses occurring when no infection of the renal pelvis is present, I should say that it is exceedingly difficult to tell the type of abscess in the kidney—whether it be disseminated or circumscribed, until the organ has been exposed. Also that it makes but little difference whether or not the renal pelvis is diseased. Presumably, however, the disease at the start is usually disseminated. The clinical observations of Brewer, that these disseminated abscesses usually occur in one organ at the beginning and the more favorable results that he had with nephrectomy than with nephrotomy in these early cases, would tend to show that it is important to make an early diagnosis and to perform an early nephrectomy. I think, therefore, that in operating on an acute case of short duration, if considerable kidney area is involved by pyemic abscesses, large or small, nephrectomy is preferable, if the other kidney is healthy.

If, in operating on a case of some duration, we find circumscribed abscesses

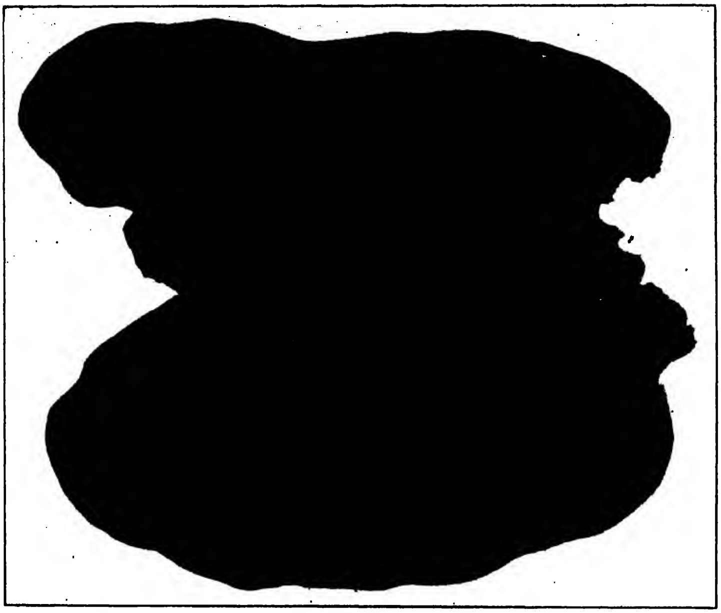


Fig. 293.

Fig. 292.

Fig. 292.—Chronic Parenchymatous Nephritis with Acute Exacerbation and Suppurating Foci (Several Circumscribed Abscesses Involving Both the Cortex and the Medulla). The kidney was 7 inches long. Nephrotomy; death. (Author's case.)

Fig. 293.—Chronic Interstitial Nephritis. The other kidney in the same case as Fig. 292, 3 inches long. (Author's case.)

present instead of the multiple miliary type when considerable healthy renal tissue is present, it is a question whether a nephrotomy or a nephrectomy is indicated. I believe that in such a case it is advisable to perform a nephrotomy, establish very thorough drainage and do a secondary nephrectomy later if the patient does not improve.

In the case of the patient with chronic parenchymatous nephritis and a number of large circumscribed abscesses on one side and a kidney with interstitial nephritis on the other, whose kidneys I am here showing (Figs. 292 and 293), the patient entered the hospital at 4 P.M. in a septic and uremic condition as an emergency case. A small amount of albumen, blood and pus cells were found to come from the enlarged and tender kidney. Nephrotomy was performed a few hours after entering, with a fatal result.

ACUTE SUPPURATIVE NEPHRITIS

Acute suppurative nephritis is said to be a rare condition, but I believe that there are many more such cases than is generally supposed, and that they are usually mistaken for other diseases. It is not a true surgical condition.

The term acute suppurative nephritis refers to a condition of acute interstitial inflammation in which numerous small purulent foci are scattered through the congested areas of the kidney substance. It is usually hematogenous in origin, though it may result from infection through the lymphatics or extension of inflammatory processes from the urinary tract. The etiologic factors are the Bacterium coli, paratyphoid and proteus bacilli, Friedländer's pneumobacillus and the pyogenic cocci, which lodge in the lymph spaces and smaller vessels, both of the glomeruli and intertubular tissue. The invaded portions soon become diffusely infiltrated with round and polynuclear cells which also enter the lumen of the tubules, subsequently reaching the urine in the form of free pus and pus casts. Considerable areas of the kidney substance may be involved, the renal epithelia often undergoing fatty metamorphosis and desquamating. If the process is not very active, the destructive changes may be slight, recovery occurring, after absorption of the pus, by regeneration of epithelium or cicatrix formation. If the inflammation is severe, cellular infiltration may be so intense as to cause liquefaction and abscess. The pus may be either absorbed or discharged into the tubules, the abscess later healing by cicatrization. Rarely, the process becomes chronic, resulting in the formation of a large pus sac.

The *symptoms* of acute suppurative nephritis are often very slight and do not point to a disease of the kidney, except when the urinary examination is made. Occasionally, the patient complains of a slight uncomfortable feeling in the back or loins, but this is not always the case. The patient may complain also of weakness, loss of weight, strength and appetite and sometimes of headache. There is acceleration of the pulse and increased temperature. The tem-

perature may range from 99° to 103° F. or higher, varying from night to morning as in typhoid, and the pulse runs from 70 to 100 and even to 120. The patient seems dull, apathetic and drowsy, and other symptoms of a general toxemia or a combination of sepsis and uremia are present.

Examination may reveal tenderness over the kidneys, and sometimes enlargement.

The urine is high colored, turbid, of high specific gravity; it contains albumin, a large amount of pus, granular and pus casts, the latter sometimes being very numerous. Urea is diminished.

The clinical picture is that of a patient suffering from typhoid fever or in a typhoid state. The disease was bilateral in the cases that I have had under observation, the involvement of both kidneys being in about the same degree. The patients were delirious part of the time.

I advised operation, but the patients refused, and, after remaining in the hospital for some time, they were able to sit up and walk about, and were removed to their homes. They recovered slowly and were able to resume their former occupations. The treatment was principally urotropin, ten grains, t.i.d.; milk and Vichy diet; saline laxatives.

The diagnosis depended on the urinary examination, clinical symptoms and ureteral catheterization.

Bilateral nephrotomy with drainage was recommended. Nephrotomy is indicated when abscesses form in one or both of these kidneys, as the condition then becomes a surgical one: a single nephrotomy if there are abscesses on but one side and a double nephrotomy if on both sides. Suppurative nephritis as described in this chapter is, as far as I can learn, always bilateral.

CHAPTER XXVI

TUMORS OF THE KIDNEY

VIRCHOW, in 1863, first described the difference pathologically between sarcoma and carcinoma. Fifteen years later, Monti described the difference between the two clinically in his article on "Sarcoma of the Kidneys in Children."

Küster, in estimating the relative frequency of these tumors in regard to age, compiled a table which shows that renal tumors occurred with equal frequency between the ages of one and five years and fifty and sixty years. Next in frequency, tumors were found between the ages of forty and fifty years. They were more common in men than in women. Of 601 cases, 348 occurred in men; the right side was more often affected than the left, while both sides were involved in only twenty per cent of the cases.

Morris compiled a table of 154 cases from the literature, in which he found 63 sarcomas, 41 carcinomas, 21 cystic degenerations, 11 hydatids, 10 adenomas, 2 myomas, 3 papillomas, 2 lipomas and 1 dermoid cyst. It will thus be seen that, according to these statistics, sarcoma and carcinoma make up two thirds of renal tumors.

Among the tumors of the parenchyma, adenomas, carcinomas and sarcomas are malignant; whereas lipomas, fibromas, myxomas, angiomas and others are nonmalignant. In some cases of sarcoma and carcinoma, there are almost no symptoms for years and perhaps the whole of the patient's life is free from suffering; while in some of the rapidly growing lipomas and fibromas and other tumors, life is ended in a few months.

NONMALIGNANT TUMORS

Nonmalignant tumors are of very rare occurrence in the kidney and their importance is proportionately small. Their presence may pass unrecognized for a certain length of time, especially when the growth is of small size. Their benign character cannot be positively established until the kidney has been exposed, the nodule incised and a part of it examined under the microscope, if necessary. The treatment may be conservative (partial nephrectomy) in the rare cases where the tumor is positively known to be benign in character, and

where only a circumscribed portion of the kidney is involved; or radical (total nephrectomy), whenever the microscope shows even the slightest suggestion of malignancy.

The following benign growths have been found in the kidney:

(1) Lipoma, (2) fibroma, (3) myxoma, (4) angioma, (5) adenoma.

1. **Lipoma.**—Lipomas of the kidney may be of two kinds: (*a*) Fatty new growths formed by a metamorphosis of the renal interstitial tissue, and (*b*) lipomas growing from the capsule. The former are small, grayish-yellow, lobulated, rounded growths found in the cortex and almost always contain nonstriated muscular fibers. According to Virchow, they rise from the connective-tissue stroma of the organ and must be carefully distinguished from the circumscribed fatty degeneration of the renal parenchyma. Both kinds may be due, however, to fetal inclusions. Degeneration into sarcomas has been observed.

2. **Fibroma.**—Fibromas are found in the kidney as small, hard, usually multiple, encapsulated, fibrous masses in the medulla or cortex. In rare cases, they attain a considerable size and are subcapsular, giving rise to cystic formations.

3. **Myxoma.**—The benign myxoma is exceedingly rare in the kidney, but myxosarcoma is more common. These growths contain masses of mucoid cells, which have substituted areas of the sarcomatous tissue and are grouped in a fine fibrous stroma.

4. **Angioma.**—True vascular growths of the kidney are of exceptional occurrence. They are usually of small size and lie beneath the capsule of the kidney, presenting the form of scarlet or purplish clusters.

5. **Adenoma.**—Adenoma of the kidney occurs in two varieties, the small and the large, which latter is usually malignant. The highly vascularized form especially has a marked tendency to malignancy. The structure of adenomatous growths simulates the structure of normal tubules, presenting the appearance of separate or multiple nodules with distinct outlines. Small benign adenomas are small nodules occurring in kidneys affected with chronic nephritis, where they appear as prominent reddish-gray nodes under the capsule, varying in size from the head of a pin to a hickory nut. They are generally circumscribed, encapsulated, and may dip into the cortex. Their clinical significance is not important, and they simply occur in chronic nephritis, as is shown at autopsy.

MALIGNANT TUMORS

Etiology.—Little is known about the etiology of malignant tumors of the kidney. We have already considered the ages at which they generally occur. They are more common in males than in females. Traumatism has been considered as a predisposing cause by some. Hypernephroma is a tumor originating from the adrenal tissue, developing either in the suprarenal gland, or more com-

monly as an ectopic growth within the kidney. It is practically limited to this organ, but occasionally occurs in other parts of the body, as the bones, lungs, liver, uterus and ovary. This variety of renal tumor is in a class by itself, and may not be considered a true renal tumor, as it cannot be classified under either epithelial or connective-tissue neoplasms. It is, nevertheless, a tumor of the kidney, and should be classified as such, even if its pathology is different from that of malignant neoplasms.

Pathology.—General Considerations.—Malignant tumors may be primary or secondary. The characteristic of the primary growths is their rapid increase in size, their tendency to metastasis, and their inclination to become generalized and to produce cachexia. They may be single or multiple.

Special Considerations.—*Malignant Adenoma.*—The malignant variety of adenoma is usually of the papillary type, whereas the alveolar type is more common in benign adenomas. The growths appear as soft, white friable nodules, varying in size from a pea to a small orange. They are situated in the cortex of the kidney beneath the capsule, which they lift up. They often have a thick capsule of their own with septa and may contain the results of hemorrhagic or cystic degeneration. Malignant adenoma develops from the epithelia of the renal tubules and gives rise to the same symptoms as cancerous neoplasms. A transition form is represented by the adeno-carcinomas.

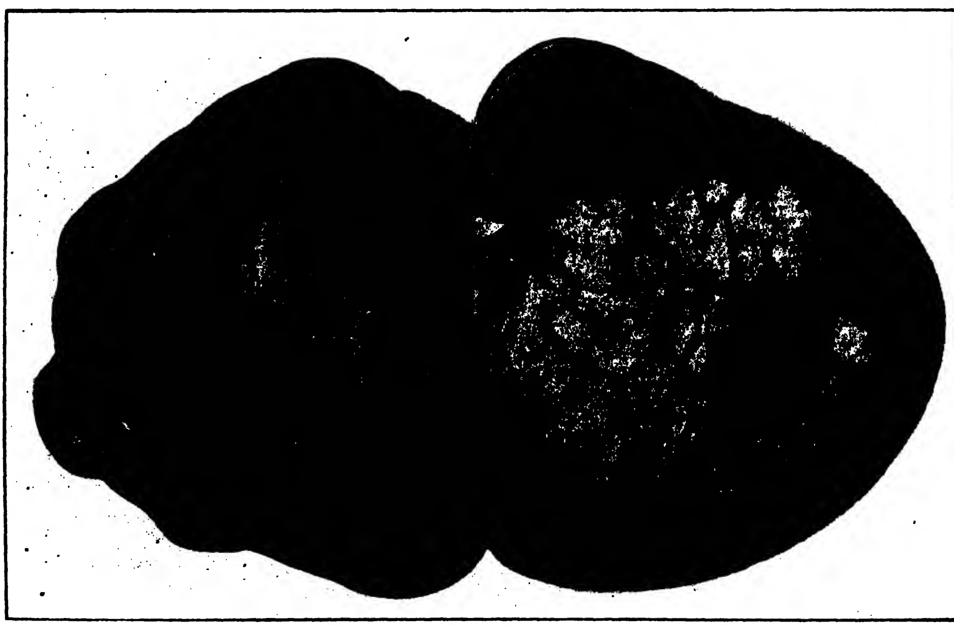


Fig. 294.—Carcinoma of the Kidney. Size of organ, 6¼ by 4 inches. Man, age sixty. It was movable and situated below the umbilicus. (Author's case.)

Carcinoma.—Carcinoma varies both in size and appearance. The tumor is more or less well defined and encapsulated, although the growth occasionally

infiltrates the renal parenchyma, causing enlargement of the organ as well. The size varies between a hickory nut and a melon, generally with a nodular surface (Fig. 294). On section, the growths appear as yellowish-white masses, divided into lobes and nodules by fibrous septa arising from the capsule. Hemorrhagic and cystic areas are present in some cases. The tumor spreads by continuity, giving rise to adhesions in the surrounding structures. The fatty capsule is quite adherent to the growth, which tends to spread forward, pushing the intestines in front of it. Metastasis takes place through the lymphatic system and the veins. The liver, lungs, glands of the hilum and retroperitoneal glands are often involved. The tumor is of the epithelial type and has a marked tendency to undergo degenerative changes.

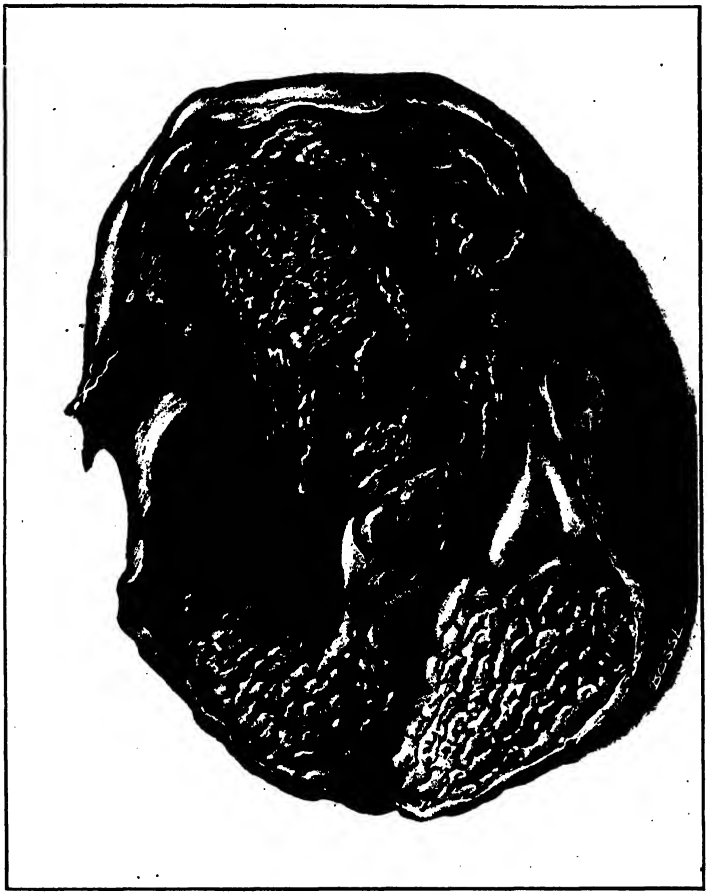


FIG. 295.—SARCOMA OF THE KIDNEY. The tumor at the time of the operation was very large, of a fragile and friable texture, and the hemorrhage was alarming. It was very large. (Author's case.)

Sarcoma.—Sarcoma is the most frequent type of renal tumor and is of connective-tissue origin, that is, derived from the stroma of the organ. These growths usually appear on one side, generally the left, and are most common in children, females being more frequently affected. Senator reports 58 cases, 35 of which occurred in children under six years of age.

The tumors are usually imbedded in the kidney substance and are often circumscribed and inclosed in a well-defined capsule. Sometimes they are diffused through the kidney, or they may be surrounded by a thin layer of parenchyma (Fig. 295). On section, they appear lobulated and vary greatly in size, sometimes reaching enormous proportions. They may spread to the ureters and renal

vessels, the retroperitoneal glands, the lungs, the liver and other tissues. Sarcomas may be of any variety, small and large, round-celled, giant-celled, spindle-celled, and melano-sarcomas. Mixed growths, like adeno-sarcoma, myosarcoma and other forms, have also been found. The presence in such mixed growths of striated muscle fibers and of cartilage cells has been explained as embryonic inclusions of neighboring tissues, or the result of sarcomatous degeneration of a dermoid at some stage of its development.

Rhabdomyoma.—This extremely malignant growth was first identified by Rokitansky in 1848, and later on received the special attention of Eberth (1872) and Cohnheim (1875). Its occurrence is practically limited to the period between the first and third year of infancy. The tumor is characterized by the presence of long slender cells, with more or less well-marked transverse striation, which have been explained as the result of fetal inclusion.

Hypernephroma.—The true character and origin of these tumors was shown by Grawitz (1883) who first differentiated them from lipomatous growths of the kidney and pointed out their heterotopic evolution upon the basis of aberrant fragments of supra-renal tissue structures resembling those of suprarenal neoplasms. His arguments were opposed by Ludeck who considered these tumors as adenomas or adeno-sarcomas, and by Hildebrand who considered them as endotheliomas. Grawitz proposed the name of struma lipomatodes aberrantæ renis. It was changed to hypernephroma by Lubarsch in 1896. The growth (Figs. 296 and 297) is practically limited to the kidney, where it rises from the portion of the suprarenal body, variable in size, which during embryonic life has remained under the capsule of the kidney or within the medullary substance. It is considered by some authors as the most common form of malignant disease of the kidney. According to Albarran and Imbarth, seventeen per cent of kidney tumors were found to be hypernephroma. The average age of patients is about fifty.

The histology of hypernephroma is very variable, and depends upon the size of the neoplasm, as well as the metamorphosis it has undergone. A small tumor, as a rule, presents the picture of the cortical substance of the normal suprarenal body. Fatty infiltration of the cells is common, and drops of fat are often quite plainly visible. This accounts for the yellow color of the tumor, which for this reason was formerly supposed to be a lipoma. Malignant hypernephroma either possesses the structure just described or it duplicates the picture of alveolar neoplasms or of sarcoma, as a result of the exuberant cellular proliferations. These tumor cells differ from normal cells by their elongated polygonal shape.

The malignant character of hypernephroma is shown by the presence of necrosis and the fatty or colloid degeneration locally, together with the resulting destruction of the surrounding tissues and organs, the penetration into the veins, and the formation of metastases along the venous circulation. This marked tendency to fatty degeneration and retrogressive changes is especially character-

istic of hypernephroma. The tumor usually occupies the upper pole of the kidney. It is generally small, about the size of a pea, and only in an advanced period of life (usually forty-five) reaches a size sufficient for recognition. It is more commonly found in men.

Fig. 296.

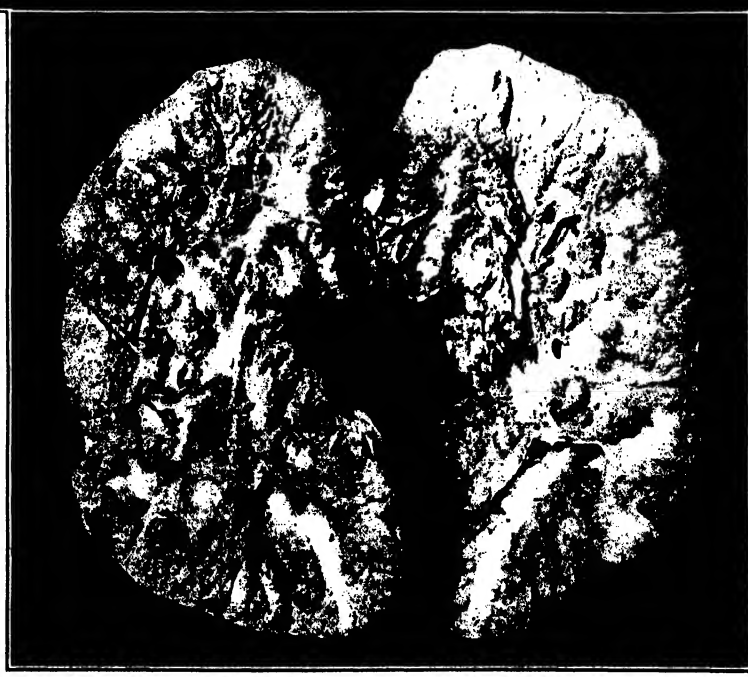


Fig. 297.

Fig. 296.—Hypernephroma, Outside View. The kidney was 8¼ inches long. (Author's case.)
Fig. 297.—Hypernephroma, View on Section. (Author's case.)

Metastasis of hypernephroma of the kidney has been observed in practically every organ and tissue of the body. The bones, lungs and the liver seem to be the seat of predilection for secondary growths of this character. The venous circulation constitutes the open avenue for the occurrence of metastatic hypernephroma. Less frequently, metastasis occurs through the lymphatic circulation. In metastatic hypernephroma, the glands of the lymphatic system are either entirely free from secondary growths, or an infection of the retroperitoneal glands is present.

Symptoms.—It is convenient to consider the symptoms of these malignant tumors without reference to their variety, inasmuch as it is generally impossible to make a clinical distinction between them. Symptoms may be absent for months or years, but when they begin to appear, they usually progress rapidly, and the patient dies in from one to three years of cachexia, asthenia, uremia, intestinal obstruction, or peritonitis. The symptoms are hematuria, enlargement, pain, changes in the urine and symptoms of pressure on other organs. Hematuria is the most important symptom and occurs in from fifty to eighty per cent of the cases, varying in the time of its appearance, its duration and frequency. It occurs without apparent cause, probably due to the fragility of the renal blood vessels induced by the neoplastic changes, while in the later stages it is probably the result of congestion or ulceration into the renal calices or tubules. The bleeding generally becomes more profuse and more frequent as the disease advances, and it is more abundant than in any other class of renal disease. The urine is uniformly reddened, and ureteral clots of a worm shape are frequently present. Considerable blood may at times be found microscopically when the urine is not reddened.

Tumefaction in the loin is not always felt, as the growth may be too small or situated too high up in the kidney to be well palpated. When it can be felt, however, it moves with respiration, has an irregular feel, can easily be ballotted and can often be better felt when the patient is lying on the healthy side with the thighs somewhat flexed.

The *pain* of renal tumors is of little diagnostic value. It is not always present and varies considerably in duration and character. It may be acute and spasmodic, but is more usually a dull persistent ache, causing a sense of discomfort in the loin. Tenderness is present in proportion to the pain.

The *urine* shows the inflammatory state and functional impairment of the kidney. Albumin is often present and the amount of urea lessened, while the specific gravity varies. Pus is found in infected cases. The most important point in connection with the urine in these cases is the presence of characteristic cells of the growth in the microscopic sediment. These cells are irregular in shape, atypical in character, not like the ordinary epithelia of the genito-urinary tract, and sometimes show fatty degeneration. Blood cells and casts are often

present when the urine shows no visible signs of hematuria. The corpuscles are sometimes pale and devoid of hemoglobin.

Pressure symptoms are due to pressure of the growth upon the adjoining tissues, giving rise to various disturbances. When it is exerted on the nerve plexuses, such as the spermatic and ovarian plexus, sensations of pain are felt in the groin and the testes, or the uterus and ovaries. When the gastric and splanchnic plexuses are involved, abdominal distress is also present. Pressure upon the vena cava causes edema of the lower extremity, whereas pressure on the renal vein on the left side often gives rise to an enormous varicocele. Cachexia is a late symptom.

The symptoms of *hypernephroma* are practically the same as those of the malignant tumors of the kidney just considered. The evolution of the tumor is very gradual and it is very characteristic of this form of renal neoplasm that it usually does not give rise to any symptom before the fiftieth year, excepting occasional attacks of dragging pains and sensations of pressure. The first reliable symptom is a characteristic hematuria, which appears spontaneously and ceases just as suddenly. In the average case of hypernephroma, spontaneous hematuria occurs for the first time about five or six years after the first pain is experienced. Generally, the hematuria is preceded by an obscure sensation of pressure and the patient readily points out the affected side in the majority of cases. The hematuria has the same characteristics as that of the other malignant tumors of the kidney. Pain is present at some stage of the trouble in eighty per cent of all cases and shows all degrees from a dull diffuse backache to severe renal colic. It may be the first symptom noticed and sometimes remains the only one. Tenderness on pressure is frequently present, especially over the site of the growth. The tumor usually does not give rise to any trouble until it begins to press upon the neighboring organs, or to produce dragging sensations on account of its increasing weight. Its growth is far from uniform and years may pass before it noticeably increases in size. It may then start another rapid growth, giving rise to severe hemorrhage. In most cases, the tumor is a late symptom. It is interesting to note that cases have been described in which twenty to thirty years lay between the first evidence of pain and the discovery of the growth. It may reach the size of a cocoanut or a small pumpkin. It is quite freely movable. The bronze discoloration of the skin, characteristic of Addison's disease, has only been occasionally noticed, even in advanced stages of this condition. The course of the trouble is irregular; it may remain practically latent for a number of years, and active proliferation may be set up at any time by abnormal conditions of the organism, such as general disease or traumatism.

Diagnosis.—This includes detection of the presence of the tumor, secondary metastatic deposits, and the variety of the growth. It is necessary to differentiate the condition from renal tuberculosis, stone, movable kidney, hydro-

nephrosis, pyonephrosis, abdominal tumors, bladder tumors and hematuria from other causes.

Tubercular kidney generally gives rise to a similar hematuria, but this is not so abundant; also to a tumefaction that resembles it greatly, but in tuberculosis the development of a swelling is more rapid. The bladder and genital tract in tuberculosis are often involved, as well as are other tissues of the body. The urine contains tubercle bacilli, it is more often purulent, and is free from tumor cells. A febrile condition is often present, and there is a response to the guinea-pig injection.

Renal calculus gives rise to hematuria, but it is usually due to exercise, is more intermittent, of shorter duration and the pain is of greater severity. The urine shows more crystals, is more liable to have pus present and contains no tumor cells, while the presence of stone is generally shown by radiography. There is no cachexia.

A tumor of the bladder gives rise to hematuria, in which case the blood is not so well mixed with the urine, and the clots are irregular and not of the worm-like character found in renal cases. The urine contains tumor cells, but the other products of irritation and inflammation found are from the bladder and not from the kidney. The presence of tumor is shown by the cystoscope, whereas no evidence of renal growth is furnished by ureteral catheterization.

Hydronephrosis rarely causes hematuria. On ureteral catheterization, obstacles may be found in the ureter; but if the catheter passes to the kidney, a quantity of retained urine will be obtained, with a low specific gravity and containing urea.

Pyonephrosis does not occasion hematuria, unless due to stone or tuberculosis. It is more frequently painful. It may be accompanied by fever, either continuous or periodical. There may be an obstacle in the ureter, prostate or urethra on catheterization; and a retention of fluid containing pus is usually found in the kidney on ureteral catheterization.

Other abdominal tumors are differentiated by a negative examination of the urinary organs. If we feel a tumor in the position which might be occupied by the kidney and find normal urine, no stricture, no enlargement of the prostate, a healthy bladder, no urinary retention, free ureters, no retention in the pelvis of the kidney, we can assume that the disease is extrarenal and independent of the kidney.

Perinephritic abscess may at times be confused with renal tumor. If this is due to renal trouble, there are usually evidences of such trouble in the urine. The condition from which it arises is generally a renal tuberculosis or a calculus, which we would be able to determine by the findings already mentioned. The tumor, moreover, is not well rounded, it cannot be ballotted and constitutional symptoms are present.

Tumors of the liver are generally characterized by a dullness extending

from the liver downward onto the enlargement, unless they come from the middle or posterior part of the organ, when they are difficult to differentiate from a renal tumor. They cannot, however, be so well ballotted. Besides this, the urine is normal, except, perhaps, when there is an increased amount of bile.

Gall-bladder tumors are not common and of smaller size; the urine is normal, while the stools are liable to be of a characteristic claylike color.

Splenic tumors are dull on percussion, extending downward and inward; the border of the tumor is usually sharper, whereas hematuria and renal elements are absent. Large ovarian cysts and tumors, as well as those from the uterus, grow from below upward, instead of from above downward like renal tumors. They can be detected in both vaginal and abdominal palpation.

There are other varieties of renal hematuria resembling that of tumor, which are painless, occur independent of exertion and are associated with an abundant loss of blood. They are spoken of as essential hematurias and are usually due to a chronic unilateral nephritis. The kidney, however, cannot be felt.

In hypernephroma, the chief diagnostic difficulties consist in the chronic and practically painless evolution of the tumor, together with its usual location at the upper pole of the kidney. Palpation is sometimes easier when the patient is placed on the healthy side with the thighs partially flexed. During the patient's respiratory movements, the examining hand must endeavor to reach up as high as possible in the diaphragm. In this way, the organ may frequently be grasped and outlined, unless the abdominal wall is very muscular or fat. Exploratory incision in the lumbar region is advisable when the disease is suspected.

Prognosis.—Unless operated upon, malignant renal tumors are usually fatal within four years after their detection. Relapses are very frequent, usually coming on within six months, but sometimes not for a number of years.

It is difficult to predict the outcome in any given case of hypernephroma, on account of its peculiar erratic and irregular course. It may remain latent as long as the patient lives; but when the malignancy asserts itself, the disease is progressive and generally terminates fatally in less than three years. Death has been observed as early as six weeks after the onset of the acute symptoms. Surgical prognosis is far from favorable. The immediate mortality after operation may reach fifty per cent. On the other hand, patients may live for a few months or a few years.

Treatment (*Nephrectomy*).—In children, the transperitoneal route is elected by some, because it gives better access to the growth; the lumbar route is preferable in adults. Albarran states that the mortality is twenty-two per cent in adults, and twenty-five per cent in children. These statistics include twenty-two operations upon adults, three of whom were in good condition more than four

years after the operation. He knows of only seven nephrectomies in children, with the patient surviving the operation three years or longer.

The treatment of hypernephroma is similar to that of other malignant growths of the kidney, and consists in nephrectomy, as soon as the other kidney has been shown by a cystoscopic and ureteral catheterization, with chemical and microscopical examination of the urine, to be sufficiently healthy to carry on the renal function.

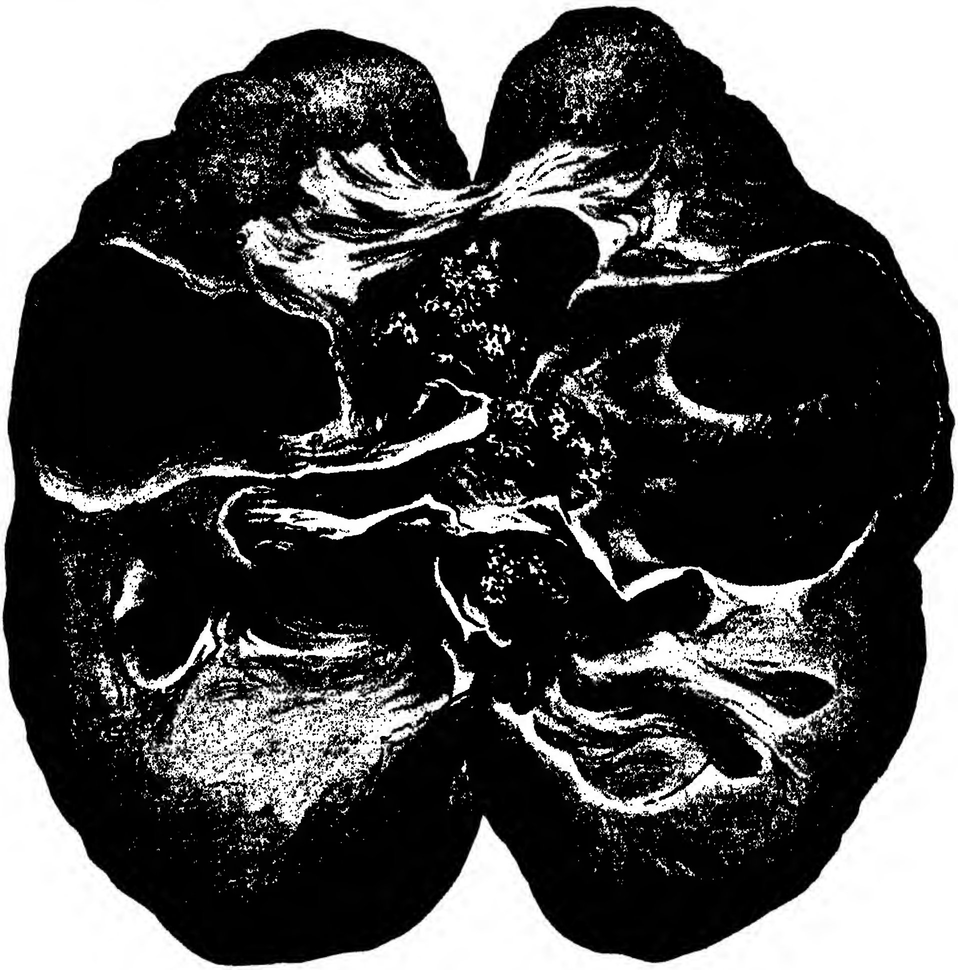


FIG. 298.—PAPILLOMA OF THE RENAL PELVIS.

The presence of metastases is a contraindication to operation. The growth is usually removed by lumbar incision, which may be extended, if necessary, by dissecting the eleventh and twelfth ribs. The fatty capsule also should be removed. Laparotomy is advocated by some operators. Profuse hemorrhage from the large blood vessels in the capsule or from the soft and injured tissues frequently causes alarming symptoms, so that every precaution should be ex-

ercised to meet severe complications by means of saline infusions and other methods.

TUMORS OF THE PELVIS OF THE KIDNEY

There are about forty-five cases of tumors of the pelvis of the kidney on record (Albarran, *Ann. des mal. des org. genito-urin.*, 1900, p. 701). These tumors may originate in the kidney and subsequently invade the pelvis, or they may arise in the pelvis itself. The most common forms of the last class are simple papilloma and epithelioma (Morris, *loc. cit.*, II, 1). Fig. 298 shows a papilloma of the pelvis. Carcinoma, myxoma, myxosarcoma, lymphatic endothelioma, myosarcoma and rhabdomyoma have also been found originating in the pelvis.

The growths often extend into the ureter. In these cases, there will be found symptoms of urinary obstruction, with all their consequences—such as hydronephrosis and suppurative diseases.

The diagnosis between pelvic and renal new growths cannot be made, as a rule, unless the ureteral catheter dislodges portions of a villous growth (papilloma) from the pelvis, or the urine contains such structures in abundance, as shown by the microscope.

The prognosis of malignant tumors of the renal pelvis is just as unfavorable as that of the same growths in the kidney. The prognosis of benign tumors (papilloma) of the pelvis is not favorable, on account of the danger of transformation into epithelioma.

Nephrectomy at an early stage is the only mode of treatment to be depended upon in these cases. Although the immediate results of surgical interference are favorable, a recurrence or a transformation to malignancy of a benign growth, in the ureter or elsewhere, is probable, and the danger persists for years after the removal of the diseased kidney.

PERIRENAL TUMORS

This class of neoplasm occurs in the fibrous or the fatty capsule. Albarran collected thirty-one cases of this kind from the literature, and states that the symptoms did not vary from those of the corresponding tumors of the kidney proper. Lipomas, fibro-lipomas and sarcomas are the most common varieties. Barring sarcoma, all these growths are characterized by their very gradual development.

CHAPTER XXVII

CYSTS OF THE KIDNEY

RENAL cysts are comparatively rare. They are on the border line between medicine and surgery, in that some are associated with nephritis and require medical treatment only, while others are in need of surgical interference.

We have the following varieties of cysts of the kidney:

(1) Nephritic cysts (cysts of sclerosed kidneys).
(2) Serous cysts.
(3) Agglomerate cysts (polycystic kidney).
(4) Hydatid cysts.

(1) **Cysts Due to Interstitial Nephritis.**—Cysts due to interstitial nephritis are very small, ranging in size from a pinhead to a small pea. They are usually multiple, and constitute a medical rather than a surgical condition. These nephritic cysts are due to compression of some urinary tubules by the new growth of connective tissue, and to the dilation of the tubules behind the constriction. The existence of these cysts should be borne in mind when operating on the kidney, and they should not be confused with cystic degeneration of the organ.

(2) **Large Serous Cysts.**—Large serous cysts are usually single, and as a rule found in but one kidney; if multiple, they do not occur in great numbers, probably not more than four or five in one organ (Fig. 299). They vary in size from an egg to that of a child's head. They have a moderately thin wall, with a smooth exterior, while the adjoining renal substance is sometimes hollowed out by their pressure.

They are filled with yellow liquid of variable consistence, which generally has a high proportion of albumin and of urea, with a variable admixture of phosphates. The cystic fluid sometimes contains cholesterin crystals and leucin balls, more rarely uric acid.

The cyst wall is made up of connective tissue lined with cuboid or flattened epithelial cells. In the immediate surroundings of the cyst, the kidney tissue presents sclerotic changes.

DIAGNOSIS.—Serous cysts of the kidney do not give rise to a clearly defined set of symptoms and therefore are difficult to diagnosticate. The two signs

usually present are slight pain and a swelling in the abdomen on the affected side. The tumor is found to be in the region of the kidney and is slightly tender on pressure. It is often stated that fluctuation is present in the tumor, but I think that the tension is too great usually to permit of such findings.

[Fig]. 299.—Large Serous Cyst of the Kidney. Size 7½ by 8 inches. (Author's ca[se].)

Serous cysts of the kidney are sometimes confounded with ovarian cysts, but differ from the latter in their form of growth, which is from above downward instead of from below upward, and also in the absence of signs on vaginal palpation. Sometimes one of these kidneys is found in the pelvic cavity in case it has become displaced there and is retained by adhesions, as was the case shown in this chapter. Ureteral catheterization is the safest method of distinguishing these cysts from hydronephrosis or pyonephrosis, as in the latter cases if the instrument can be passed into the renal pelvis, then the tumor will quickly disappear.

Treatment.—The usual treatment of such cysts is incision and drainage, after which they are liable to recur. It is better, therefore, to dissect away the

cyst wall in cases in which adhesions are not too great, or else to bring the incised sac out of the wound. To do the latter, insert a catheter in it and inject with tincture of iodin or some other fluid to cause an adhesive inflammation between its walls. Resection of that part of the kidney from which the cyst originates (partial nephrectomy) has been successfully performed by D'Antona, Recamier and Albarran in five cases, but does not appeal to me as a desirable procedure. Nephrectomy is justified in cases in which the kidney is extensively destroyed as it frequently is through pressure of the cyst. The cystic kidney (Fig. 299) was removed at operation.

(3) **Agglomerate Cysts** (Polycystic Kidney).—The whole kidney may be involved by a conglomeration of cysts. They may be congenital or may develop

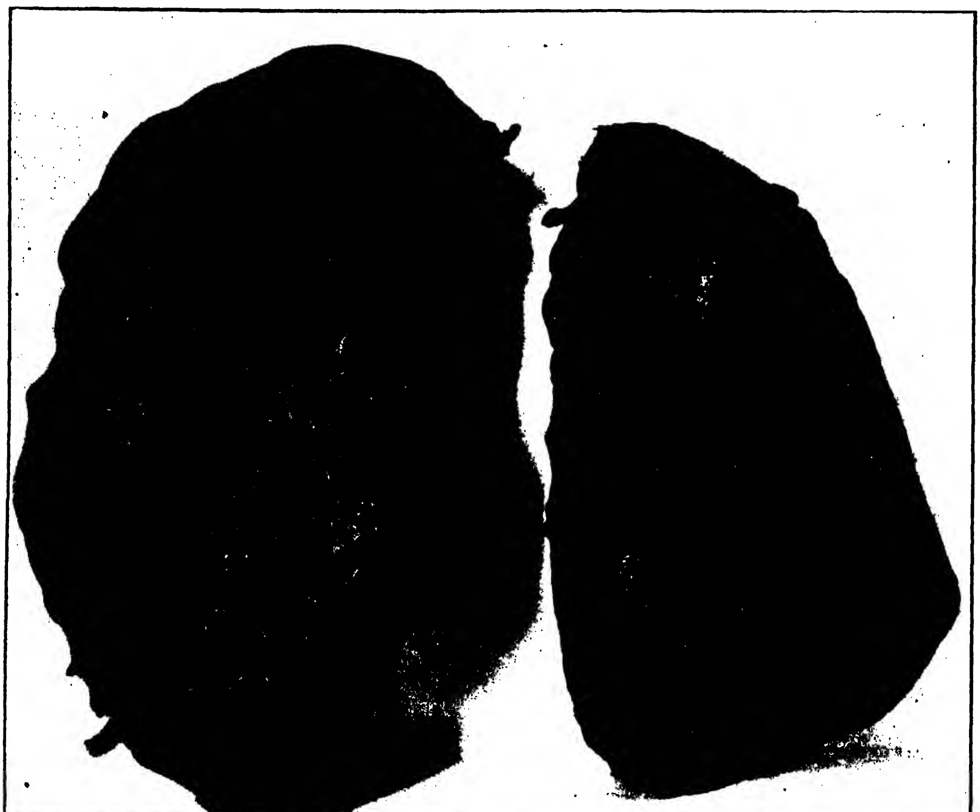


FIG. 300. TWO LARGE POLYCYSTIC KIDNEYS IN THE SAME INDIVIDUAL. The larger kidney was 10 by 5½ inches, weight 56 ounces; the smaller, 9¼ by 5 inches, weight 48 ounces. Removed at autopsy by P. F. O'Hanlon. (City Hospital case. Author's collection.)

in adults. The condition is almost always bilateral. The kidney may attain an enormous size and may resemble a bunch of grapes, weighing five or six pounds or more. The cysts are translucent, opalescent, thin-walled, of the size of a grape or smaller and some are tinged with red, brown or green. They may

be packed closely, communicating with one another or they may be separated by septa of fibrous or renal tissue. They are filled with a clear fluid of a gelatinous consistence, containing crystals of cholesterin, leucin, albumin, urea and phosphates (Figs. 300 and 301).

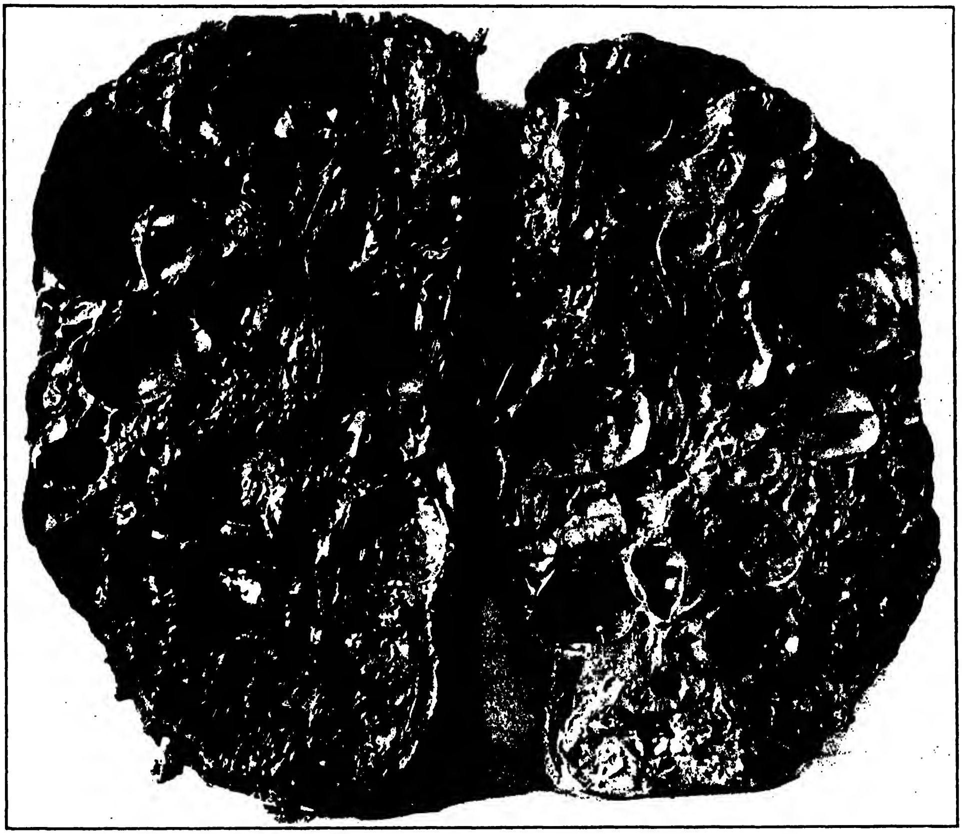


FIG. 301.—THE LARGER KIDNEY IN FIG. 300, ON SECTION. (Author's collection.)

CAUSES.—Numerous theories have been advanced as to the mode of formation of these cysts, but the disease seems to be of the same origin in infants and in adults. Virchow believed that this degeneration was due to a stenosis of the papillæ occurring in the fetus as the result of intra-uterine nephritis, while others believe that the disease is a true process of new growth, i. e., that there is first an adenoma and that later this tumor degenerates into cysts. Finally, some authors believe that the cystic degeneration of the kidney is due to congenital malformation, consisting in a nonunion of the excretory and the convoluted tubules.

SYMPTOMS.—The symptoms are those of chronic nephritis. There are occasionally pains in the kidneys, and these organs are found enlarged on both sides. The pain is a vague one with a sense of weight in the loin which rarely

becomes acute, colicky. Although the general shape of the organ is maintained, the irregular outline of the cysts can plainly be felt in thin subjects, the cysts appearing to the touch like an irregular, embossed padding of the kidney. There is usually polyuria and low specific gravity, diminished urea, albumin and sometimes blood in the urine.

As the disease progresses and the excretory function of the kidney diminishes, the patient generally begins to show uremic symptoms and the course of the disease becomes the same as that of any nephritis where renal function is impaired. The patient may live for years with gradually degenerating kidneys. The dangers threatening such patients are anuria and the infection of the cystic kidney.

Diagnosis.—Agglomerate cysts of the kidney may be confounded with a malignant tumor, but such tumors are rarely bilateral and puncture would fail to produce any fluid. The condition is sometimes mistaken for hydronephrosis, but this is also usually unilateral and does not contain a fluid with so much albumin or colloid material as determined by ureteral catheterization, besides which the wall of a hydronephrotic kidney is smooth.

Treatment.—The treatment is symptomatic and otherwise the same as in a case of chronic nephritis, the aim being not to bring any undue strain upon incapacitated kidneys. Operative interference is not called for and the removal of one of the kidneys would be unwise and would simply lessen the already deficient area of secreting renal substance by at least fifty per cent. Anuria and death would be likely to follow under these conditions, as the opposite organ is usually in about the same stage of degeneration.

Sieber collected sixty-one cases of cystic kidney in adults, where nephrectomy was performed with a known outcome, including twenty deaths. Fully one half of the patients died from uremia or anuria, on account of simultaneous cystic degeneration of the other kidney. The only excuse, then, for nephrectomy in a cystic kidney would be the occurrence of suppuration or malignancy in one of the organs. If the diagnosis is uncertain, an exploratory incision may be performed, but, on finding the kidney cystic, it should be left alone unless movable, in which case it can be fixed in place.

(4) **Hydatid Cysts.**—Hydatid cysts of the kidney are rare and according to Houzel there were but 115 cases in 2,111 of echinococcus disease. The left kidney is more often affected than the right. The cyst is rounded, elastic, situated deeply in the kidney or projecting from its surface. Hydatid cysts may be single or multiple and may finally destroy the whole kidney.

In hydatid cysts of the kidney there is usually very little acute pain, although sometimes it is most distressing, but generally a dull dragging feeling. The kidney is enlarged and can usually be outlined in the lumbar region. The cyst frequently bursts into the pelvis of the kidney when the characteristic hydatid substances and hooklets are found in the urine. In such cases, the cystic

cavity may become infected, giving rise to a pyonephrosis and the consequent symptoms of a renal infection. Hydatid cysts are rarely confounded with solid tumors of the kidney, although they may be mistaken for certain pathological conditions of the organ.

Hydronephrosis may be distinguished by ureteral catheterization, and aspiration will differentiate hydatid from other renal cysts through the fluid containing the characteristic hooklets.

Aspiration is not advisable for diagnostic purposes in renal cases unless the kidney has first been exposed by a lumbar incision.

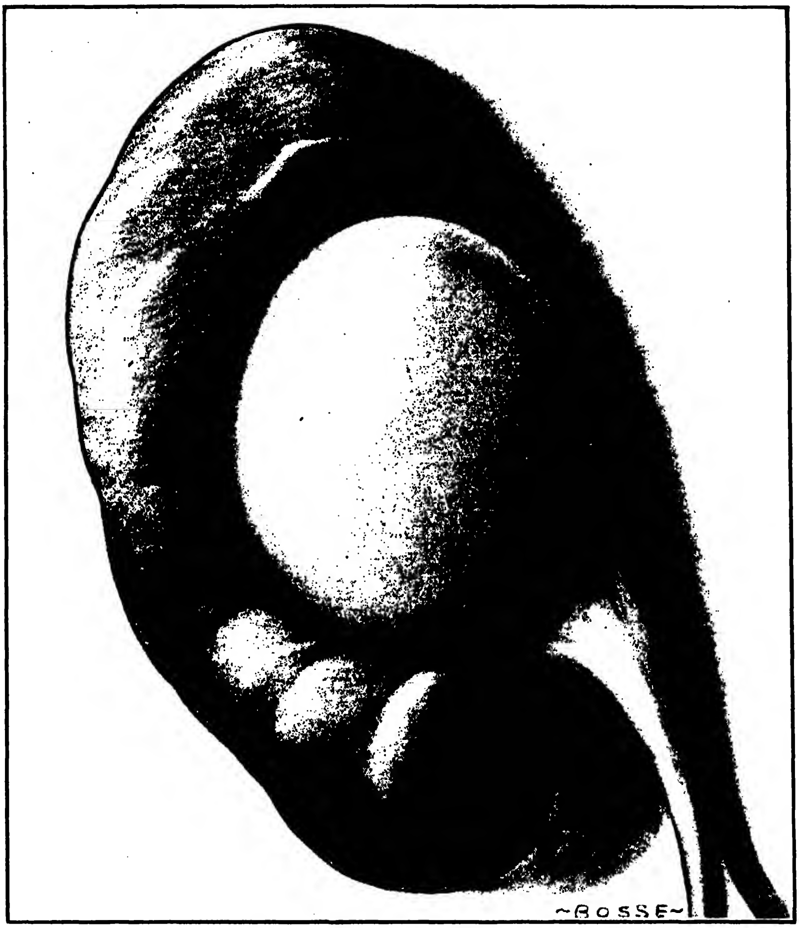


FIG. 302.—HYDATID CYST OF THE KIDNEY.
The organ was stretched out by the cyst and was 8 inches long. (Author's case.)

TREATMENT.—The cyst should be evacuated, and as much as possible of the cyst wall should be cut away and the free edges sewn into the abdominal wound.

Sometimes all the cyst wall can be cut away, excepting the part in or on the kidney, in which case that portion of the wall can be treated by an applica-

tion of pure carbolic acid followed by alcohol which will destroy the secreting cyst surface and not injure the kidney tissue. I have operated on one of these cases which was treated in this way (Fig. 302).

The patient was a housewife, aged twenty. Three years ago she had an attack of severe pain in the right lumbar region and groin, lasting for three days, during which time there was hematuria. One month ago she had an attack of very acute pain in the same locality. Her urine was bloody and was voided with difficulty. The severity of the pain gradually diminished, but there has remained more or less pain on that side since the attack. On the first visit her temperature was 98.4° to 100° F., pulse 92 to 130. The right kidney was enlarged and tender, extending over to the median line. Cystoscopy showed the bladder to be normal. The ureters were catheterized. The urine from the left side was secreted normally, and was found normal on examination. The urine from the right side flowed more slowly, was very pale and contained a trace of albumin, a few blood and pus cells, a few hyaline casts, renal epithelia, uric acid and triple-phosphate crystals. No exact conclusion was arrived at regarding the case, and an exploratory incision was made. The kidney was found to be very much enlarged; the upper pole was enlarged and adherent to the diaphragm, the lower pole was smaller and twisted. A cyst with a thick white sac, three and a half inches in length and two and a half in width, was seen springing from the anterior surface of the kidney and the pelvis. This was opened, and a considerable amount of amber fluid and a number of small white daughter cysts escaped. The outer surface of the sac was dissected away, and the remainder treated with carbolic acid and alcohol. During the first week after the operation, the temperature ranged from 100° to 104° F., pulse 136, due to ether pneumonia, then went to normal, and the patient left the hospital with the wound healed.

CHAPTER XXVIII

NEPHROLITHIASIS

Nephrolithiasis means stone in the kidney. All these stones are originally of a small size, but on account of certain conditions under which they form in the kidney, or on account of the locality, some remain in the organ, while others are washed down the urinary tract and are voided in the urine. Although this chapter treats of stone in the kidney proper, it will also discuss stone in its passage through the ureter, giving rise to renal colic and anuria.

Etiology.—Renal calculus occurs more frequently in males than in females, and may be found at any age. Statistics show that there are certain periods of life during which stone is most frequently noticed, especially between the ages of twenty to fifty. The order of frequency is first between twenty and thirty; second, between thirty and forty; third, between forty and fifty; fourth, between fifteen and twenty; fifth, between fifty and sixty. In children the condition is comparatively rare. Uric-acid infarcts have, however, been found in the new-born, and it is therefore possible that the calculus may begin to form at a very early age. During my service in the St. John Guild Hospital for children, I did not have a single case of renal calculus; and but one case came under observation in the children's wards of the Columbus Hospital in fifteen years, notwithstanding the fact that nearly all these children were Italians, among whom urinary calculus is very frequent.

Country and race have some influence on the development of stone. Warm countries seem to favor it as is shown by the frequency of renal calculus in India. This depends greatly upon the concentration of the urine due to the active elimination of water through the skin.

Nephrolithiasis is said to be more frequent among the Anglo-Saxons than the Latin races. I think, however, that such conclusions are due to the fact that better statistics and more complete records on this subject have been published in the Anglo-Saxon countries than elsewhere. Personally, I have found calculus more common in this country among the Italians than any other race, and the history of medicine shows that in the past more provisions were made for the relief of stone in the urinary tract in Italy than in any other country. In the United States, renal calculus is comparatively rare, among the native-born Americans.

The formation of calculus is also favored by overeating, especially nitrogenous and carbohydrate foods in excess, as well as by the free use of wines, beers and liquors, in people who take but little exercise and therefore consume an insufficient amount of oxygen. Heredity and constitutional factors, such as uricacidemia, oxaluria and phosphaturia, are also predisposing factors. A movable kidney sometimes predisposes to the formation of stones.

The *immediate cause* of renal calculus is the deposit of the crystals in the urine upon some object in a tubule of the kidney, or in its pelvis, that will act as a nucleus. It usually takes place in the pelvis or one of its calices, and is rare in a renal tubule. Among the objects that have been found in the central parts of calculi and upon which the crystals have been deposited are foreign bodies, blood clots, masses of mucus or pus, microörganisms and parasites.

Foreign bodies usually enter the kidney through *traumatism*, such as a bullet, a fragment of bone, or a piece of the clothing; or *surgically*, in the form of ligatures, sutures, or gauze used during an operation. At present, it is also possible that a nucleus may occur from the breaking off of the end of a ureteral catheter. Blood clots may be due to any variety of traumatism, or to any form of renal hematuria. (See chapter on Hematuria.)

The presence of mucus in the renal tubules or pelvis may be due to any cause of a sufficiently irritative character to produce congestion, followed by destruction of the epithelia, such as crystals in the urine; certain drugs, like cantharides; or certain pathological products excreted in the urine during infectious diseases. Pus is present in the renal pelvis in all inflammatory conditions, due to pus-producing microörganisms, and can therefore frequently serve as a nucleus for a renal stone.

Regarding the part that parasites and bacteria play in forming the nucleus of a calculus, opinions differ. Bilharzia hematobia has been found in the central portions of calculi. Bacteria have been reported in calculi by Gallippe, Doyen and Fullerton, but it has not been generally accepted that they act as a nucleus. I can only say that I believe it to be usually blood, pus or mucus, singly or combined, and that these act as the cement so often spoken of as a necessity to hold the urinary crystals together.

Varieties.—Two varieties of stone are the *primary* and *secondary*. The primary stones are formed by the precipitation of substances excreted by the kidney without any previous change in the parenchyma, the pelvis or the calices. Secondary stones are the result of pathological processes in these localities, and are formed when certain salts are precipitated owing to the decomposition of the urine. Of course, a calculus may be originally primary, and by its presence so irritate the surrounding tissues that lesions develop which give rise to secondary calculous deposits over the primary calculus.

Of the primary variety of calculi, we have those formed in acid or in alkaline urine. The varieties developing in acid urine consist of one or more of

the following substances: Uric acid, urates, calcium oxalates, cystin and xanthin. Those formed from alkaline urine consist of calcium carbonate, acid phosphates of calcium, or basic phosphates of calcium.

Secondary calculi are precipitated from alkaline urine rendered so by ammoniacal decomposition, due to some local infection or inflammation. They consist of *phosphates,* either of ammonium or of magnesium, or of both ammonium and magnesium.

Occurrence.—The frequency with which the various calculi occur differs according to locality. Oxalate of calcium calculus is said to occur more frequently in Great Britain than either the uric acid or the phosphatic variety and produces the worst cases of nephrolithiasis. In France and most of the Latin countries as well as the United States, the uric-acid variety is more prevalent.

Fig. 303.—Some Large Calculi Removed from a Pyonephrotic Kidney. The largest diameter of these calculi was 4, 2½, 1¾, 1½, and 1¼ inches, respectively. In the reproduction they are about three quarters of their actual size. (Author's case.)

The number of calculi in a kidney varies from one to over two hundred, and is greater in suppurative conditions of the organ. In size they vary from grains of sand to masses weighing five pounds. Uric-acid stones with secondary deposits are usually the largest, while oxalic calculi rarely exceed the size of a nut. Fig. 303 shows some large-sized calculi removed from a case of pyonephrosis.

Stones are more often found in the right kidney than in the left, probably because it is more frequently movable, while the frequency of stones occurring in both kidneys is variously estimated at from five to fifty per cent. From my own observations I believe that from five to ten per cent is a liberal estimate of the occurrence of bilateral nephrolithiasis as it occurs in this country.

Pathology.—Primary calculi may give rise to aseptic or septic changes. They irritate the pelvis of the kidney, causing congestion and later fibrous thickening of its wall, an aseptic pyelitis, followed by secondary nephritis of an aseptic type. In this combined aseptic pyelo-nephritis, the inflammatory process begins in the renal parenchyma, later involving the interstitial framework of the organ. It is always present in calculous kidneys, and other lesions may become associated with the nephritis when the stones have reached a considerable size and have remained in the organ for a long time, especially if they cause obstruction of the ureter. The first of these secondary lesions is renal atrophy. Sometimes the perirenal fat is increased sufficiently to form a large lipomatous tumor containing the atrophied kidney, while in other cases the mechanical obstruction by the stone gives rise to hydronephrosis.

The septic lesions of primary calculi are secondary to the aseptic changes. The infection reaches the kidney by the hematogenous or the lymphogenous route, or ascends directly from the bladder. The predisposing factors of septic infection which exist in calculous kidney, are the traumatic effects of the stones, the urinary retention which they may give rise to and the capillary congestion of the organ.

The results of infection in calculous kidneys are pyelitis, pyelo-nephritis, pyonephrosis and perinephritis.

The lesions of septic pyelitis are the same as those of the aseptic type plus the presence of pus. Septic pyelo-nephritis results when the infection has involved the parenchyma as well as the pelvis of the organ, in which case abscess formation frequently occurs. It has been noticed, however, that when the sclerotic process that is present in aseptic pyelo-nephritis is sufficiently advanced, the kidney itself seems better able to resist the invasion of bacteria. In twenty-seven per cent of my series of cases, pyelo-nephritis was present. Pyonephrosis takes place when the calculous obstruction has been sufficient to cause retention of urine in the pelvis of the kidney, giving rise to pelvic dilatation plus infection—Fig. 304 shows a case of acute renal retention and pyonephrosis; also when the calculi have themselves increased in size to such an extent as to press upon the parenchyma of the organ, and form cavities (Fig. 305); or when the parenchyma has been destroyed by abscesses in pyelonephritis and cavities remain communicating with the pelvis. Pyonephrosis occurred in seventeen per cent of the cases that I have observed. In these, the fatty capsule was often thickened and the seat of fibrous changes.

In pyelo-nephritis and pyonephrosis, a true perinephritis may develop and adhesions may bind the kidney to the surrounding organs, a fact of importance to be remembered when operating in such cases, as they may involve the duodenum, colon and even the vena cava. In case the capsule of the kidney ruptures, the pus may burrow in any direction, making a true perinephritic abscess. I have had quite a number of such cases, that I have already discussed in the chapter on Suppurative Diseases of the Kidney.

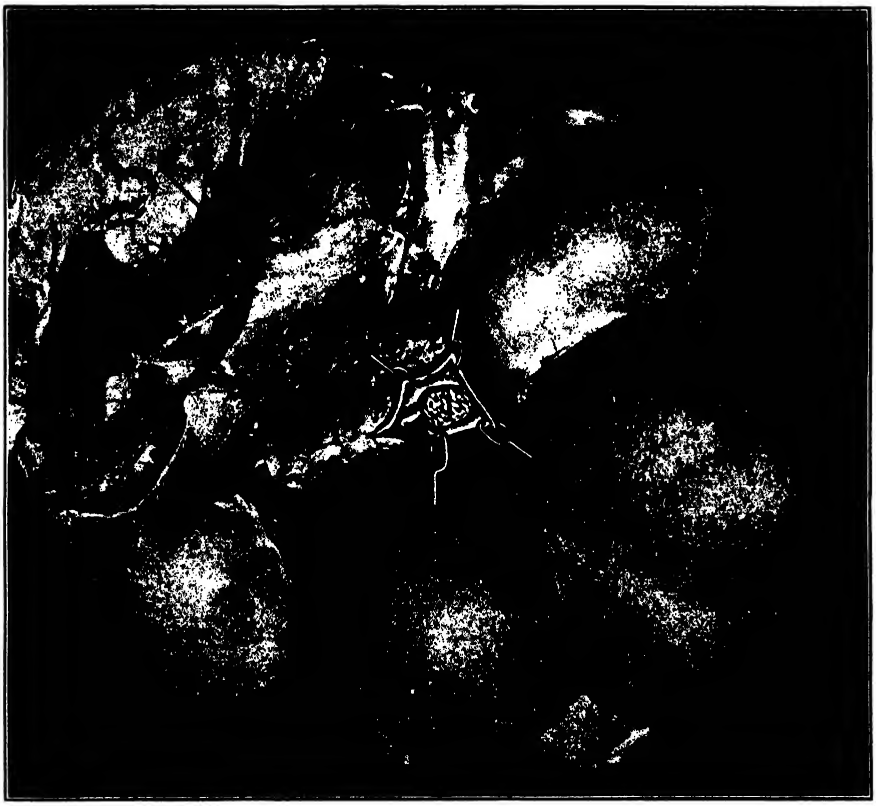


FIG. 304.—A PYONEPHROTIC KIDNEY IN A STATE OF ACUTE RENAL RETENTION OF URINE. A calculus is seen caught in the beginning of the ureter. The size of the kidney is 9 by 5½ inches. (Author's case.)

The opposite kidney often becomes the seat of compensatory hypertrophy, in its effort to make up for the loss of functionating tissue in the diseased organ, due to the atrophic changes in its parenchyma or to suppurative processes. A secondary nephritis usually follows, not only on account of the extra amount of work that is thrown upon the organ, but also on account of the irritation from the acid urates, oxalates and phosphates it is obliged to eliminate. Calculi may also form in the second kidney. It is likewise more prone to secondary infection.

Symptoms and Diagnosis.—In considering nephrolithiasis, we must bear in mind that most patients have active subjective symptoms, but there are many in whom these are absent. In these cases, the stone remains in the kidney in such a position that it does not cause irritation or attacks of urinary retention. Bruce Clark found, in 13 of 24 autopsies on persons in whose kidneys calculi were present, that there had been no symptoms whatever during life referable to

FIG. 305.—THE RENAL PELVIS OF A PYONEPHROTIC KIDNEY FILLED WITH FIVE STONES OF LARGE SIZE. There was also an attack of acute renal retention present in this case, and the affected kidney contained over a pint of pus.

nephrolithiasis. I wish, therefore, to emphasize, at the beginning of the clinical part, that the symptoms are not always in proportion to the extent of the disease, and that I have often been surprised to find how few subjective symptoms a patient has had when his kidney has been nearly destroyed by a calculus.

In some cases, the existence of renal stone is not suspected because the train of symptoms is obscure, or for the reason that they point to other organs, as the bladder, the uterus, the ovaries, the testicles or to the gastro-intestinal tract. In the majority of cases, however, the subjective symptoms are marked and often most distressing.

PAIN.—Pain occurs in most cases, and is situated in the lumbar region corresponding to the affected side or in that side of the abdomen. This had been

present in 92 per cent of my cases for a period varying from six days to twenty-two years, with an average duration of four years. The right side is most frequently affected, and in my own cases the relative frequency was 65 per cent on the right side and 35 per cent on the left, while the pain was bilateral in but 6 per cent. The abdominal pain may run down to the groin or the testis on the affected side. It is of varying degrees of intensity, from a dull ache to the excruciating, sharp, cutting pain of renal colic. It may be continuous, but generally follows exercise or jolting, although cases have been reported when it occurred at night.

It is renal colic that usually causes the patient to consult a physician, especially if it be associated with or followed by hematuria. In my own cases, thirty-three per cent complained of this symptom. Attacks of colic occur when a freely movable stone begins to engage in the mouth of the ureter, or to descend along the canal. The forces that propel a stone along the ureter in such cases are said to be threefold, viz.: The pressure of pent-up urine behind it, the forcible contraction of the ureter under the irritation produced by a foreign body, and the alternating positive and negative pressure of the act of vomiting which often accompanies the attack of colic.

The clinical picture of a patient in the throes of renal colic is not easily forgotten when once seen. The facial pallor, the cold sweat, the flexed thighs, the bending of the body during the agony of the paroxysm, are sufficiently typical to direct our attention to the probability of a stone in the pelvis of the kidney or passing through the ureter. The pain is acute, paroxysmal, has its chief seat in the loin or in the side of the abdomen, and radiates along the ureter toward the testicles or the labia majora, or into the thigh, according to the course of the spermatic or ovarian plexuses and their communications.

The access of pain is frequently preceded by a chill, and complicated by attacks of nausea and vomiting. The paroxysm usually lasts from two to three hours, and, as a rule, terminates more or less abruptly, the patient feeling relieved and falling asleep.

In milder cases, the pains are not so colicky or paroxysmal, and consist simply of slight pricking sensations along the course of the ureter, accompanied by a feeling of slight nausea.

During an attack, the urine may be passed frequently. It may be clear, of low specific gravity, in case the ureter or the uretero-pelvic opening is completely obstructed by the calculus, as it then comes from the healthy kidney. If the ureter is not completely obstructed, the urine may be tinged with blood; or turbid, in case the kidney is infected. The frequent desire to urinate depends upon the locality of the calculus, as the nearer it is to the bladder, the greater is the frequency.

Ureteral blood casts are sometimes passed in the urine during the attack, but usually not until after the expulsion of the calculus.

The cases in which the stone remains in the kidney or pelvis, without giving rise to attacks of renal colic, are those that present the greatest difficulties in diagnosis. Reflex or referred pains are often met with in nephrolithiasis, and frequently mislead the diagnostician. They existed in twenty per cent of my cases and were situated principally in the groin, testicle and thigh. In such instances, the renal region may be free from pain. The pain may be seated in the lumbar sensory nerves, or in the sciatic nerve, as in lumbar sciatic neuritis.

The reflex pains of nephrolithiasis have been classified by Guyon as follows: The reno-renal, reno-vesical, reno-ovarian or reno-uterine and reno-testicular reflex.

The reno-renal reflex is a sensation of pain in the kidney that is not supposed to contain a stone, and is attributed to its reflex transmission from the affected side, in other words, from one renal plexus to the other. Such a manifestation is, I believe, rare, and is based upon the idea that the kidney which is not thought to contain the stone is a healthy one. Recent investigation, especially since the development of ureteral catheterization, has shown that this other kidney is generally not a normal one, in fact, that it is usually the seat of a nephritis. The painful symptoms in this so-called healthy kidney can be accounted for in various ways. The healthy organ may be the seat of an occasional acute congestion when an extra amount of work is suddenly thrown upon it, owing to the calculus in the diseased kidney engaging in its pelvis and thus interfering with its function. The pain may also be more acute in the so-called healthy organ when it is the seat of an inflammation that is much less extensive than that of the other organ although more acute in character; again when it contains a stone, not identified by radiography, which is rougher and consequently more irritating; or when there is a stone present of a size just sufficient to interfere with the urinary flow and to cause an acute distention of the pelvis. The reno-renal reflex occurred in six per cent of my cases.

Regarding the reno-ureteral reflex, the reno-ovarian and reno-testicular reflexes, I will say that such pains are due to the pressure of the calculus on the sensory nerve fibers of the spermatic and ovarian plexuses at the beginning of the ureter in the pelvis, or lower down in case it is descending the canal, and are consequently distributed to the organs supplied by these nerves.

The reno-vesical reflex can be explained in a similar way, although pain in the bladder can also be due to a stone in the part of the ureter that is contained in the bladder wall.

The gastro-intestinal reflex is a more genuine reflex, because in this case the pains are reflected from the urinary to the gastro-intestinal tract through the connection between the renal, spermatic, or ovarian plexuses on the one hand, and the gastric or splanchnic plexuses on the other. This probably accounts for the large number of patients who complain of dyspepsia, by which name they describe an unpleasant feeling in any part of the abdomen, such as can be pro-

duced by an indigestion, by pressure of the kidney on the adjoining organs, or by a renal urinary retention. The woman with the large pyonephrotic kidney containing numerous calculi (see Fig. 305) complained only of dyspepsia and attacks of malaria.

HEMATURIA.—If the reason for consulting a physician for this disease is not pain, then it is usually the presence of blood in the urine. This is one of the most frequent symptoms of renal calculus, and was complained of in thirty-seven per cent of my cases. The bleeding in these cases occurs in sufficient quantity in the urine to be detected by the patient. It is aggravated by movements and by prolonged standing, and lessened by rest in bed. It is due both to congestion and to injury of the tissues caused by friction from the stone, or to congestion of the wall of the pelvis, in case it is distended by a stone blocking the ureteral opening. Oxalic calculi are the roughest and therefore especially liable to cause hematuria. The urine and blood are freely mixed, giving the color of porter, and in case clots are present, they are thin and elongated, of a wormlike appearance (ureteral clots).

I have seen a number of interesting cases of hematuria due to renal stone, occurring while playing ball, riding horseback, boxing and indulging in other athletic sports. Hematuria in such cases follows pain in the affected side. In the case of a grocer, the patient stated that when, in his work, he lifted objects from the ground, especially barrels and baskets of groceries, blood would appear in his urine. I had him come to my office for a cystoscopic examination and put him through the same movements with pulley weights and dumb-bells that he made when lifting in the store, to see if hematuria would be induced; but it was not, showing that hematuria cannot be brought on at will, or else the patient's statements are not always truthful.

PYURIA.—Pyuria, strictly speaking, means that pus can be detected in the urine on microscopical examination; but clinically it means there is a sufficient amount of pus to make the urine appear opaque or turbid, and show a light precipitate on standing. It usually occurs in the course of nephrolithiasis, and the amount may be so abundant as to form twenty-five per cent or more of the urine by volume. In many cases the urine has a milky color, while in others it resembles lemonade. Pyuria occurred in over fifty per cent of the cases under my observation.

GENERAL EXAMINATION.—Palpation, it is said, will in certain cases reveal the presence of stones, if they are of sufficient size. This may be true, and I believe that a kidney that can be sufficiently well palpated to detect undue hardness will probably prove to be either a calculous kidney or a malignant kidney. I have noticed enlargement of the organ in thirty-three per cent of the cases of renal calculus that I have examined, but have never felt the stone. It is often possible to determine the presence of tenderness, the degree of mobility and size of the organ by palpation, which are important points, as an inflamed kidney,

especially if it contains a foreign body, is very apt to be enlarged and tender and firmly attached by inflammatory adhesions.

The kidney is tender in nearly all cases in which it is enlarged, but it cannot always be outlined. A normal kidney cannot usually be felt and is not tender to the touch.

There are other symptoms that may occur in nephrolithiasis that may be mentioned as digestive disturbance, such as nausea and vomiting, abdominal distress and poor appetite. These are usually due either to pressure or dragging on the duodenum or colon, to an accompanying nephritis, or to a septic condition in case of infection. Headaches are probably due to an associated nephritis or sepsis, as are weakness and loss of weight. Edema occasionally occurs when the renal function is very much impaired.

Fever is quite common in nephrolithiasis after infection has taken place. This may be due to retention of pus in the pelvis of the kidney, after the stone has engaged in the ureter in pyonephrosis; or to a pyelo-nephritis, in case of the presence of an abscess in the renal parenchyma; or to a complicating perinephritic abscess. It is usually due to attacks of pyonephrosis, in which cases the symptoms closely resemble malaria and are accompanied by chills and sweating, with a rapid pulse.

THE URINE.—The examination of the urine of patients suspected of nephrolithiasis should be performed by a skilled pathologist or bacteriologist; the practitioner should not be satisfied with his own examination.

The amount of urine is usually decreased. The reaction is generally markedly acid, except in cases of phosphatic calculi or advancing pyonephrosis; the specific gravity varies with the amount of diluents taken; the color may be darker than normal in early cases, and if hematuria be present, the urine has a smoky-brown or portlike color. The urine shows a sediment varying in color from white to dark brown or red; in old and septic cases the color is usually lighter, due to the absence of the coloring matter and solids and a large admixture of pus. The examination usually shows the presence of albumin, and an excess of uric acid and urates, phosphates or oxalates, as the case may be.

Microscopical findings depend upon the stage of irritation or inflammation of the kidney and consist of blood, pus, epithelium from the tubules, the renal pelvis or the ureter, casts (hyaline, granular, epithelial, blood, pus or mixed) and bacteria. Often there are small concretions of crystals or masses of crystalline sediments, such as calcium oxalate, triple phosphates, uric acid and urates, pointing to the nature of the stone in the organ.

When urine of this kind is found in a patient suffering from pains or colic in the region of the kidney, the pains coming usually during the day after exercise, one may strongly suspect stone in the kidney on the side on which the pain is felt, especially if there are no tubercle bacilli in the urine or any signs of tuberculosis in other organs. It is, therefore, important to examine the bladder

by cystoscopy to determine the condition of its walls, the presence or absence of calculi, and to note the urine coming out of the respective ureters. Naturally, this refers to an examination not occurring at the time of renal colic. The bladder wall, in case no vesical calculi are present, and there is no obstruction to the flow of urine by an enlarged prostate or stricture, would be in a healthy condition. In case of renal infection, pus would be seen coming from the ureter of the affected side indicating the presence of calculus and strengthening the clinical findings.

It may be well to say a few words regarding the difference between aseptic and septic nephrolithiasis. They differ principally as to the presence of pus and pus casts. If we are confident that the kidney on one side is diseased and do not know the condition of the other, we can feel reasonably sure that it is functionating well if it is not enlarged or tender and if the twenty-four-hours' urine is of sufficient quantity and contains the desired percentage of solids. In order to be more certain of the condition of the two organs, we should examine the urine obtained from each kidney by the ureteral catheter.

The urinary specimens obtained by ureteral catheterization, compared with the general specimen, usually gives us a good idea of the kidney that is secreting the good urine and its functionating power, as well as the degree of inflammation and degeneration of the affected kidney. The appearance of the urine coming through the catheter often tells us something of the pathological condition of the kidney on that side. A light-colored, milky urine, of low specific gravity, is generally a mixture of water and pus with a small quantity of solids, and indicates pyonephrosis. Urine resembling lemonade generally points to a kidney secreting a considerable amount of water and a small amount of solids, and, if it contains considerable pus, also points to a pyonephrosis. In pyonephrosis, a thin purulent urine of low specific gravity may escape quickly on the introduction of a ureteral catheter, showing the pelvis to be considerably dilated. When the kidney is greatly destroyed and secretes but little fluid, a thick and often pure pus escapes. In one case, such a mass resembled closely a pebble in the bladder hanging from the ureter.

By the urinary examination, cystoscopy, catheterization of the ureters and cryoscopy, we would know that a practically destroyed septic kidney is present on the side from which the pathological urine escapes, and that, if nephrolithiasis is present, the stone is on the septic side.

Radiography.—Radiography is the most important method that we have at present for determining the presence of renal calculus, although it cannot always be relied upon, as we often see a shadow in kidney pictures in cases where no stone is found at operation; and we also frequently see no shadow in cases in which all the symptoms point to stone clinically, and in which an operation shows a stone to be present. Nevertheless, when a clinical diagnosis of stone has been made, and the X-ray finding corroborates it, we can feel quite positive that

nephrolithiasis is present. The X-ray revealed a stone in seventeen per cent of the cases I observed, but this cannot be considered accurate, for a number were not X-rayed and a shadow pointing to stone was revealed in certain cases in

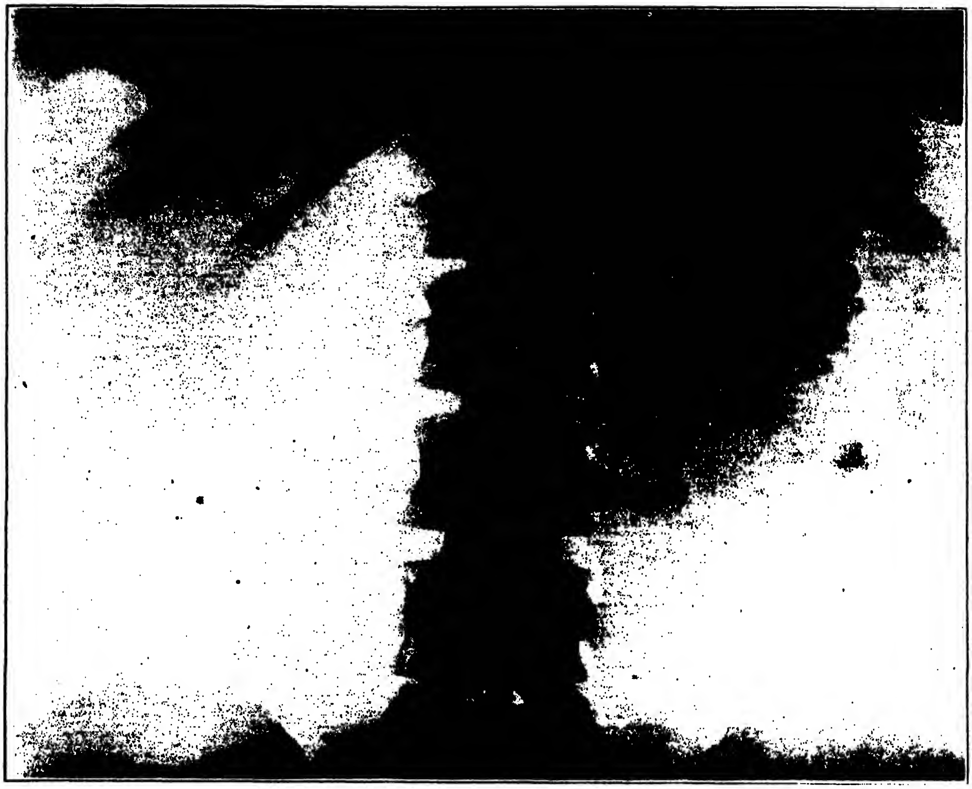


FIG. 306.—A CLUSTER OF STONES IN ONE KIDNEY. The position of these stones was found to have changed in the different radiographs taken. (Author's case.)

which the operation proved its absence. Radiography not only shows the stones but their number and positions. Fig. 306 shows a cluster of stones in the kidney of one of my patients; Fig. 307 shows a cluster in each kidney.

Until recently, many radiographists claimed that uric-acid stones could not be seen, and some still believe this to be true, although the majority of X-ray experts maintain that calculi of whatever composition can be detected under favorable conditions.

The most important factor in obtaining a satisfactory picture is to have the bowel thoroughly empty when the patient is to be radiographed. This is best obtained by giving calomel the night before, followed by a saline aperient in the morning, at least three hours before the radiograph is taken. It is often advisable to have a patient X-rayed on two or three different occasions in a case in which the clinical findings point to stone and the X-ray findings are negative.

The exploratory incision is always justifiable in a case of chronic suppurating disease of one kidney, to determine whether a stone is present in the kidney or not. If one is found, it should be removed and, in any case, the pelvis explored and drained. It would seem that an exploratory nephrotomy would at once establish the diagnosis, but I will show by a case that I will mention under treatment (Fig. 308) that this may fail, even when one feels that he has been careful in the exploration.

Differential Diagnosis.—Stone in the kidney is more apt to be confounded with *tuberculosis* or tumor of that organ than with any other renal disease. The principal points of differentiation lie in the history. In favor of the calculus there may be the presence of gout, rheumatism or lithemia in the indi-

Fig. 307.—A Cluster of Stones in Both Kidneys. (Erdman's case.)

vidual or in the family, while tuberculosis may be suggested by a tuberculous history on the part of the patient or the family. Tuberculosis of the kidney usually comes on more rapidly and the patient is more cachectic; the pain and hematuria occur independently of exertion and often take place at night as well as by day, while, in cases of calculus, these symptoms occur almost always dur-

ing the day. In renal tuberculosis, there may be an involvement of the genito-urinary tract elsewhere, as in the bladder, prostate or testis, and tubercle bacilli will sooner or later be found in the urine, or after guinea-pig inoculation, whereas radiography would be negative.

In cases of *tumor* of the kidney, the patient is usually of a more advanced age, the pain is not as great and occurs independently of exertion. The malignancy of the growth is expressed by the cachexia and loss of weight which accompanies these cases. In such patients, the hemorrhages are much more abundant and not necessarily associated with exercise, moving or jolting. The organ is usually clearly outlined; the urine may contain characteristic tumor fragments or cells, and is not apt to contain crystals. The pain is always in the back and loins.

A *movable kidney* may also give rise to a dull ache in this region or even to renal colic (Dietl's crises); hematuria is rarely present or is slight, pyuria rarely develops and pyelitis, pyelo-nephritis and pyonephrosis are only exceptionally associated with it. The mobility can be discerned on examination, it is generally not as large as a calculous kidney and the signs of renal destruction are not so marked in the urine. I have had cases of movable kidney, however, in which stone was present, requiring the double operation of nephrolithotomy and nephropexy.

Bladder diseases caused by stone, tuberculosis or tumor, with or without an associated cystitis, or bladder involvements due to stricture, prostatic hypertrophy or gonorrhea often have to be differentiated from nephrolithiasis. In these cases, hematuria, pyuria or both may be present. A urethral and rectal examination, associated with visual exploration of the bladder by means of an examining cystoscope, will clear up the diagnosis, by showing gonorrhea, ureteral stricture or prostatic enlargement on the one hand; or vesical calculus, tumor, or vesical tubercles or ulcers on the other. In the cases of nephrolithiasis that I have studied, cystitis was present in twenty-three per cent of the cases, and vesical calculus in two per cent.

Nephralgia is the most difficult condition to differentiate from renal calculus. It is characterized by a pain of the neuralgic type in the renal region on one side, which can be accounted for by any surgical condition of the kidney as well as by a nephritis. The only method of arriving at a diagnosis is by excluding all pathological conditions in the kidney that can give rise to pain. This is often impossible, and the probabilities are that many of the cases that are considered nephralgia are really obscure forms of nephrolithiasis.

Certain forms of nephritis accompanied by pain and hematuria closely resemble renal calculus by the attacks of pain and bleeding. In these cases, the urinary crystals and the signs of pyelitis are not so common, the signs of suppuration are rare, the kidney is not enlarged and radiography is negative. Nephrolithiasis has been mistaken for *malaria* in many patients that have been

sent to me, due without doubt to an occasional renal retention of pus when the calculus blocked the ureter and the consequent giving rise to chills, fever and sweating. A number of other abdominal conditions, such as cholelithiasis and appendicitis, have been confounded with renal calculi. *Gall-stone* is suggested by a history of gastro-intestinal disturbances, location of the tenderness in front, the pain radiating backward and upward and negative findings in the urine. It is practically impossible, at times, to differentiate between cholelithiasis and nephrolithiasis when the patient is seen in an acute attack of colic.

Appendicitis can also be at times mistaken for nephrolithiasis, especially in suppurative cases, with or without renal retention, or in which there is calculus in that part of the ureter passing beneath the cecum; for in such cases, we will be liable to have pain in the region of the appendix. In one case, all these symptoms were present and the diagnosis of the house surgeon was appendicitis. The patient was brought to the table for operation, an incision was made over the tumor, the appendix was found to be slightly congested and the lower pole of the kidney was found to be crowded up beneath the cecum and appendix forming a distinct tumor. The patient had consented to an operation for appendicitis, and the appendix was removed. Upon investigating this case, I found that pus had been found in the urine together with pus casts. The case proved to be one of pyonephrosis, depending on a renal calculus, which was subsequently removed.

Treatment.—The treatment of nephrolithiasis is both medical and surgical. It depends upon the symptoms of the patient, and the aseptic or septic nature of the case.

Medical Treatment.—The medical treatment is symptomatic and palliative. If the case is an aseptic one, treatment depends upon the size of the calculus. One of such a large size that it is retained in the kidney and cannot pass through the ureter is treated according to the symptoms that it presents.

If there is great pain, especially in the nature of a colic, morphin should be given until the pain has subsided. When an attack of hematuria occurs, the patient should be kept quiet and Basham's Mixture (*mistura ferri et ammoniæ acetatis*) should be given in half-ounce doses, three times a day. In case the hematuria is severe, fifteen drops of the fluid extract of ergot and fifteen drops of the tincture of chlorid of iron should be given every three hours until it has subsided. Personally, I have never as yet seen a case of renal calculus in which the hemorrhage was sufficiently severe to warrant the use of ergot.

Diet.—I would also give the patient a diet suitable for the accompanying nephritis (see chapter on Nephritis), and would recommend operative interference. The diet in nephrolithiasis is very important. For the associated nephritis it should be the same as in Bright's disease, but it should be modified according to the crystals found in the urine. If oxalate of lime is present, then the diet of oxaluria is given; if uric acid, then the diet of uricacidemia; if

phosphates, then the diet of phosphaturia. (See diets in the chapter on Diseases of Metabolism.) During an attack of renal colic, a milk and Vichy diet should be given in all cases.

If the calculus is a small one and passes into the ureter, causing colic in its passage down to the bladder, I would also give sufficient morphin to alleviate the pain. After it has passed and no more pain is present, I would treat the patient on prophylactic or preventative lines; in which case, I would give the diet indicated by the crystals found on urinary examination, such as one for oxaluria, uricacidemia or phosphaturia. Diluents are also of great value. For the uric-acid diathesis, the waters of Contrexéville in France, of Wildungen in Germany and other alkaline diuretic waters should be given. In a case of oxaluria, I would give carbonated alkaline waters, such as Apollinaris. Bitter waters containing magnesia have also been recommended. For phosphaturia, an acid treatment such as dilute nitro-muriatic acid, fifteen drops three times daily, will be beneficial. Phosphorus, nux vomica and arsenic are useful medicinal agents, in these cases, and urotropin when bacteria appear in the urine.

In septic cases, the treatment is the same as in aseptic conditions plus the treatment of suppuration. For surface suppuration, such as occurs in the pelvis of the kidney and in the larger tubules that are not blocked, as well as in cases in which there is some retention and alkaline decomposition in the renal pelvis, urotropin ten to fifteen grains three times daily, benzoic acid, or some other urinary antiseptic, should be given. In cases, however, in which there is acute suppuration in the parenchyma of the kidney, such as occurs in pyelo-nephritis, or an acute attack of retention in a pyonephrotic kidney with pus absorption, quinin and whisky should be given. This applies also to a perinephritic abscess complicating a suppuration of the kidney.

In other words, the same treatment as in any other septic case is followed, it being remembered, however, that the kidney is involved and consequently the parenchyma is damaged in a greater or less degree. In my opinion, quinin and alcoholics are the best general remedies for fever due to sepsis, and I therefore recommend them during an attack, being careful, however, to avoid doses that will not be well tolerated by these organs. I am in the habit of giving three grains of quinin three times a day, and one ounce of whisky three or more times a day.

Sometimes it is difficult to differentiate between tuberculosis of the kidney and stone, especially when radiography is negative. In the event of the diagnosis being doubtful, and when it is a question whether stone or tuberculosis is present, as often happens when the X-ray is negative and tubercle bacilli are not found in the urine, I give the patient creosote until the question of tuberculosis has been eliminated. (See chapter on Renal Tuberculosis.)

Operative Treatment.—This is the radical treatment for stone in the kidney and should be employed in all cases in which a stone is retained in the

organ, or in which one passes into the ureter and completely blocks it, giving rise to a hydronephrosis, a pyonephrosis or anuria, in which last instance it becomes an emergency case.

The operations employed in the treatment of nephrolithiasis are: Pyelotomy, nephrotomy, primary nephrectomy, secondary nephrectomy and ureterotomy. In any case of nephrolithiasis, whether symptoms are present or not, the diagnosis having been made, the stone should be removed. This applies to both aseptic and septic cases. In clean cases with the clinical diagnosis of stone, not confirmed by X-ray, in which other renal conditions have been excluded, an exploratory nephrotomy should be performed. This applies also to septic cases, and should not be postponed in case the patient is losing weight and strength.

In patients suffering from nephrolithiasis, we may say that if the function of the diseased kidney is fair, as shown by examinations of specimens of urine obtained by ureteral catheterization, the operation should be nephrotomy; but in case the two specimens show that the function of the diseased kidney is very much impaired and that the organ is a pus sac of no value and injuring the health of the individual, a nephrectomy should be performed, provided that the other kidney has sufficient functionating renal tissue to excrete urine of the required amount and character. When there is a question of doubt before the operation is performed, whether nephrectomy or nephrotomy should be done, it is advisable to obtain the patient's permission to do whichever is considered better after cutting down upon and examining the organ. Sometimes we operate to do a nephrotomy and find that the kidney is so damaged that it should be removed, and that the patient's condition is such that a nephrectomy could easily be borne; but we do not feel justified in removing the organ after having told the patient that the operation was to be a nephrotomy. It is better, then, having obtained the patient's consent to do what seems to us to be advisable, to remove the kidney if, upon examining it, we find that it is simply a pus sac. In such a case, if a nephrotomy were performed it would be extremely difficult for the wound to heal afterwards, and a urinary or suppurative sinus from the kidney would remain that would injure the patient's health and reduce the resistance to such a degree that a secondary nephrectomy would not be so well borne.

After the kidney has been delivered, it should be examined by holding it in one hand and palpating it carefully with the fingers of the other over its entire surface. The ureter should then be palpated and the forefinger pushed up along the ureter, invaginating into the hilum with the object of palpating the calices.

In some cases, it is advisable to perform *pyelotomy*, that is, to make a small incision in the posterior wall of the pelvis parallel with the course of the ureter, in order that the calices may be palpated and a stone, however small, detected.

Very little hemorrhage attends such an operation, and a small stone, if present, can easily be withdrawn by forceps.

Needling the kidney is of no value and has never given me any results. This is especially unsatisfactory in cases of pyonephrosis with retention of pus. Sometimes areas of induration are felt in a kidney that closely resemble stone, but which prove on opening the kidney to be only dense nodules of tissue.

Aspiration is of value in pyonephrotic and hydronephrotic kidneys, especially if the ileo-costal space is small, as, after having emptied the sac, it is easier to deliver the kidney and the organ can also be more thoroughly palpated. It is also of value in case a nephrectomy is contemplated, as it is much easier to ligate the pedicle after withdrawing the retained pus and urine from the kidney.

If aspiration is performed in these cases, it is well to connect the end of the cannula with a soft-rubber tube and allow the pus to escape into a vessel outside of the operative field. The cavity can then be washed out with an antiseptic solution after its contents have been withdrawn.

This method of visual examination and palpation of the kidney after its delivery, together with the urinary analysis already made, will give us a fair idea of whether the kidney is tolerably healthy or extremely diseased.

Aspiration of the kidney does not interfere with any operation that we may be called upon to perform later.

Nephrotomy, incising the kidney through the parenchyma into its pelvis is, of course, the operation *par excellence* for the removal of stone or for inspecting the interior of the kidney, and I have operated thirty-one cases by this method. The hemorrhage is often quite profuse, thus preventing the operator from inspecting, as clearly as he would like, the pelvis and calices, notwithstanding the fact that the vessels of the pedicle are compressed by an assistant with his fingers, by padded clamps or by a rubber band.

After a nephrotomy in clean cases, I have closed the kidney and the abdominal wall as well, without drainage, and the recovery has been satisfactory. It may be well to say, however, that recovery from operation is not always assured even in an aseptic case, and I well remember one case which I considered very promising in which the patient died very quickly. It was that of a young man, tall and athletic, on whom I operated some years ago and closed the external wound after removing the stone and suturing the kidney, but the patient died of uremia and sepsis in two days, notwithstanding the fact that the wound was fully opened and drained on the following morning as soon as serious symptoms appeared.

In a clean case of nephrotomy, the kidney should be closed and a wick or cigarette drain should always be left in the wound from the convexity of the kidney and allowed to remain for twenty-four hours, when it can be removed if

there is no urinary leakage; but in case the urine is leaking away, the drain should remain in for a longer period.

In cases which are apparently clean, but in whose urine pus has been found by the microscope, the kidney should be drained by a tube in its pelvis after nephrotomy.

When a stone is removed from a movable kidney, as occasionally happens, the kidney should be fixed to the abdominal wall after nephrotomy has been performed.

In cases of pyelitis, pyelo-nephritis or pyonephrosis, there may be a purulent discharge from the kidney through a sinus in the loin for several weeks, or perhaps several months, unless further operation is resorted to. In favorable cases, three weeks may be spoken of as the average time for a sinus to close, whether it be urinary, purulent or both. Sometimes a sinus will close and the patient will have an elevation of temperature, showing that pus has accumulated outside of the kidney, in which case it will be necessary to reopen the wound. It is, therefore, important to put a drainage tube down to the organ, and not to insert it between the skin and the muscular walls. In one case, a perinephritic abscess developed, the pus burrowing along the ureter and forming a tumor in the groin, while in another it burrowed down below Poupart's ligament and had to be opened in the thigh.

A nephrotomy does not always reveal the stone. In one case, after opening the kidney, carefully examining the pelvis and exploring it with a probe, I drained the organ and treated it as usual; but as the patient continued to run a septic temperature and was losing ground, I performed nephrectomy and discovered a calculus hidden behind a dense barrier of thick fibrous tissue, in a space connecting both with the renal pelvis and the perirenal space by sinuses. The pelvis had been palpated and probed, without success, before its removal, but afterwards by bending the probe in a certain direction it could be passed into the pocket where the calculus was concealed and from there into the renal pelvis. Fig. 308 shows the stone lying in a pouch surrounded by a dense mass of fibrous tissue held to one side by a hook.

Nephrostomy, that is, a nephrotomy plus the fastening of the walls of the incised kidney to those of the abdominal incision is sometimes more satisfactory, as the organ can be better drained and the dressing of the renal pelvis is easier than when the organ slips up under the ribs as it usually does after nephrotomy. In ten per cent of the cases operated on, I employed this method. While drainage is better during the after treatment by this means, the kidney remains lower down than normal after the operation and later on the ureteral drainage into the bladder may not be so good as if the organ had been drained from its normal position.

Nephrectomy or removal of the kidney, can be performed in cases of pyelonephritis with numerous abscesses, or in cases of pyonephrosis in which the

organ is merely a pus sac containing stones, or when it is but a mass of sclerosed tissue. I performed nephrectomy in twenty-one per cent of the cases.

Secondary nephrectomy is the same as primary nephrectomy unless there are very dense adhesions present, which is often the case if the operation is delayed too long after the nephrotomy. A source of danger in pus cases is the tearing of the peritoneum and infection of its cavity. I have unfortunately torn through the peritoneum on three occasions, in two of which I sewed up the membrane again, and in the other walled it off with a piece of gauze. In none of the cases did peritonitis occur.

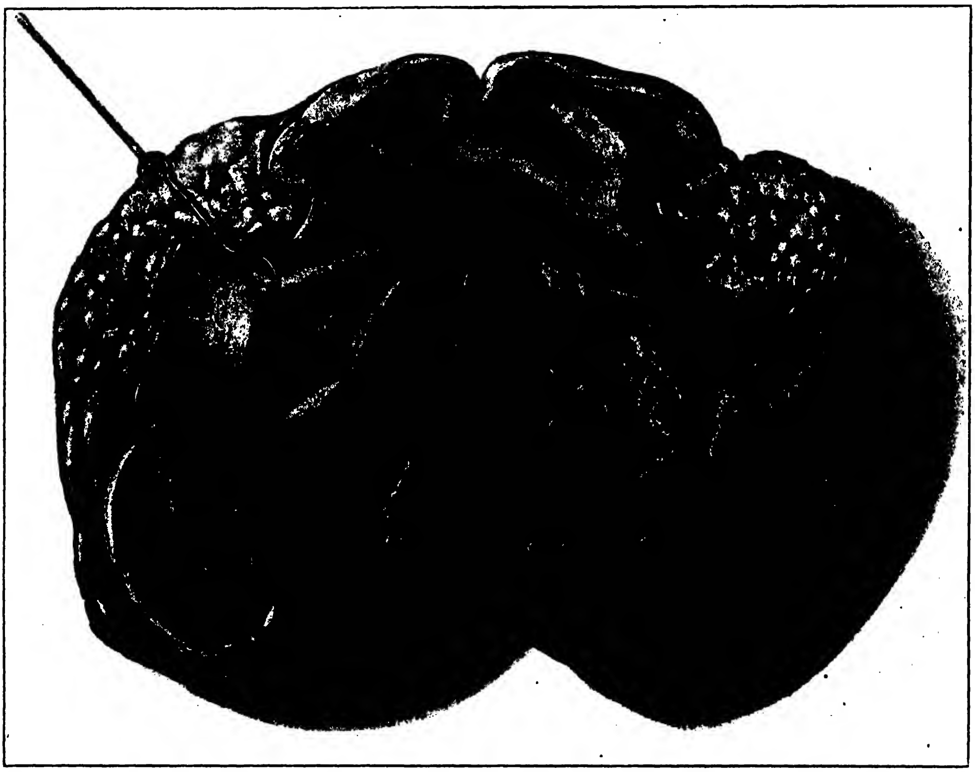


FIG. 308.—A CALCULUS CONCEALED IN THE THICK MASS OF FIBROUS TISSUE HELD OPEN BY THE HOOK NOT DETECTED BY NEPHROTOMY. The kidney was in a state of pyonephrosis. (Author's case.)

Subcapsular nephrectomy is a safer operation in cases in which both the capsula propria and the fatty capsule are thickened and adherent and the leaflets of the perirenal fascia are also thickened; for it is comparatively easy to remove these combined capsules from the kidney, whereas to separate them from one another often causes a considerable prolongation of the operation, and induces shock. I know that many patients who are in a weakened condition die from the extra exposure to which they are subjected when the usual nephrectomy

is performed, whose lives might have been saved had a subcapsular operation been performed.

Partial nephrectomy is generally a dangerous operation and one that I have performed but once. In this case, a renal calculus had caused a pyonephrosis with a destruction of the kidney; an abscess of the organ developed, broke and discharged outside of the kidney, causing a perinephritic abscess. The stone escaped with the pus and was found lying outside of the kidney. In this case, the kidney was practically destroyed and I attempted to remove it, but found the adhesions to the surrounding tissues so dense anteriorly and along the pedicle, that I was afraid to remove the entire organ lest I tear the vena cava. I accordingly removed half of it. The kidney was so fibrous that scarcely any blood was lost during the operation. Fig. 309 shows a stone that was discharged from the kidney into the renal fossa when a kidney abscess discharged through its capsule, giving rise to a perinephritic abscess. The half of the kidney removed was a mass of fibrous tissue. The piece remaining was evidently nonfunctionating, as no permanent urinary sinus remained in the loin.

Fig. 309.—A Renal Calculus that Was Discharged through the Wall of the Kidney, Giving Rise to a Perinephritic Abscess. (Author's case.)

The local treatment of the patient after the operation depends upon the operation performed and the existing conditions. In a case of nephrectomy in which a large pyonephrotic kidney has been removed without any infection entering the renal fossa, the wound can be closed and the patient needs no further local treatment unless some complication develops. But when a nephrectomy immediately follows a nephrotomy, or in the case of a secondary nephrectomy, a cigarette drain should be passed down to the pedicle of the stump, as the wound has probably been infected by the leakage of pus during the nephrotomy operation.

Temperature and Pulse.—After operation, the temperature and pulse range as follows: On the day of operation, the temperature ranges from 98.6° to 100° F. and the pulse from 90 to 140; the temperature ranges from 98.6° to 99° F. in a mild case, and 100° F. or more in one with more severe symptoms.

On the first day after the operation, the temperature in mild cases ranges from 98.2° to 100° F.; in others from 100° to 102° F. The pulse in mild cases ranges from 90 to 106; in others from 100 to 130.

On the second day after the operation, the temperature in mild cases was from 99° to 100° F.; in others from 100° to 102° F. The pulse in mild cases was from 85 to 100; in others from 100 to 130,

On the third day, the temperature in mild cases was from 98.6° to 99.2° F.; in others from 103° to 106° F., usually fatal. The pulse in mild cases was from 80 to 100; in others from 100 to 130 or even 160, usually fatal.

In favorable cases, the temperature and pulse become normal in from four to six days; first of all in clean nephrotomy cases, next in primary nephrectomy cases in which the kidney is delivered without being opened. Cases of extensive pyelo-nephritis and pyonephrosis are apt to run a long febrile course after nephrotomy and sometimes do not reach normal for several weeks. The course after secondary nephrectomy is indefinite, frequently requiring two weeks or more for the reëstablishment of normal pulse and temperature.

A temperature of 104° F. and a pulse of 130 on the second or third day after an operation, whether it be nephrotomy or nephrectomy, is a very dangerous symptom. A slight temperature after nephrotomy points to a slow absorption of pus while the walls of the opening down to the kidney are closing together to form a sinus. In case the temperature continues to go up slowly together with sweating, and perhaps chills, we must think of a general sepsis. If, on the other hand, the temperature goes up suddenly and the drainage is found to be insufficient, it would point to a local accumulation of pus in the region of the kidney.

The treatment of these cases is as follows: In the first instance, while the drainage tube is in the kidney, the renal pelvis should be washed out daily with a 1:4,000 solution of nitrate of silver, and later, when the tube is in the sinus leading down to the kidney, this opening should be irrigated twice a day with 1:2,000 solution of bichlorid. In case of an abscess formation due to retention of pus in the wound, usually about the kidney, it is opened by blunt dissection, with the finger or otherwise, and afterwards washed out with peroxid of hydrogen. In case of a general sepsis, a thorough local examination is made, any pus pockets found are opened and the whole of the operative area is then washed out twice daily with peroxid of hydrogen. The patient is treated internally with small doses of quinin three times a day, and whisky from a half to one ounce as often as indicated. If the patient does not improve in this way, the kidney should be removed by a secondary nephrectomy.

Urine after Operation.—After a nephrotomy, blood is voided in the urine for from one to ten days. The urine voided varies in amount. Usually on the first day after the operation one pint is voided and on the second day after from one to one and one half pints or more, dependent upon the amount of water taken and the activity of the kidneys.

After a nephrotomy, there are always changes in the urinary balance, that is, the amount of urine voided and the amount leaking away from the renal pelvis through a rubber drainage tube into a bottle by the bedside. In order to observe this carefully, a chart can be kept, showing the gain on one side and the loss on the other.

Table Showing Changes in the Amount of Urine in Ounces Coming from the Kidneys Voided after Nephrotomy

	First 24 Hours	Second 24 Hours	Third 24 Hours
Voided	24	28	34
Drained	18	16	13

	Fourth 24 Hours	Fifth 24 Hours	Sixth 24 Hours
Voided	37	40	44
Drained	11	9	8

	Seventh 24 Hours
Voided	47
Drained	8

In case the amount of drainage diminishes to a certain degree and then stops and remains at about that figure for some time, the decrease will be again observed after inserting a ureteral catheter *a demeure.*

Sinuses and fistulas have been observed, after both nephrectomies and nephrotomies. In nephrectomy, a suppurating sinus may remain until the ligature has become either absorbed or thrown off. After nephrolithotomy, fistulas are said to follow in six per cent of cases lasting for varying periods—weeks, months or years. Such a percentage corresponds in the cases I have operated upon.

Mortality.—In fatal cases following nephrotomy, the patients usually die of asthenia, sepsis or uremia. After a secondary nephrectomy is performed as well as in primary nephrectomy, they may die on the table from hemorrhage; or on the same day from shock; after a few days from anuria; or later from uremia or asthenia.

One clean case already mentioned, operated upon by nephrotomy, in which the renal pelvis was in good condition and the involved kidney but little diseased, died in sixty hours after the operation, of uremia and sepsis. I had closed the wound in this patient without drainage, but on the following day, when his temperature went up, I opened it again, washed it out and inserted drainage, although no pus was present. In most of the fatal cases of nephrotomy under my observation, there was a pyelo-nephritis or pyonephrosis in the diseased organ and a nephritis in the other kidney as well. In nephrectomy, the deaths were usually due to anuria when occurring shortly after the operation, to sepsis when the period was somewhat longer and to uremia when the deaths occurred still later. All my nephrectomies were performed on patients with septic kidneys.

Results of Operations.—My own results have been 10 per cent mortality in nephrotomies and 30 per cent in nephrectomies; mortality in partial nephrec-

tomy, none; in nephrostomy, none. Nearly all my operations have been in pus cases, aseptic cases having been exceptionally rare.

The results vary greatly according to the presence or absence of septic complications in the kidney, thus: (1) In aseptic cases the mortality after nephrotomy was less than 4 per cent; (2) in septic the mortality after nephrotomy was 20 per cent, but has been as low as 10 per cent; (3) in septic cases (*a*) primary nephrectomy gave a mortality of 33 per cent, which of late has been reduced to 20 per cent, (*b*) secondary nephrectomy gave 23 per cent mortality.

In a number of cases of nephrolithiasis, a *perinephritic abscess* is present when we first see the patient. In these cases, there is often a large amount of pus, distorting the tissues, pushing the kidney out of place and preventing us from examining it thoroughly. In all such cases, having made an incision, evacuated the pus and washed out the cavity, the surgeon should insert a finger and explore the cavity.

Sometimes the kidney can easily be brought to view, the opening explored with the finger, or a nephrotomy performed at the time, thus allowing better drainage. If, however, it is difficult to examine the kidney intelligently at this time, the drainage should simply be extrarenal, the drainage tube being inserted in the most dependent part of the abscess cavity. Then, after a few days, nephrotomy can be performed.

A few years ago, I occasionally used to do a nephrotomy in such cases at the time of evacuating the abscess.

Cases of calculous kidney giving rise to perinephritic abscess are usually those in which the suppuration has destroyed the parenchyma as far as the capsula propria, which it has stretched and thinned to such a degree that it bursts easily. The pus escapes into the perinephritic tissue, whereas the stone remains in the kidney. In one case, a sharp-pointed calculus was found protruding three quarters of an inch beyond the surface of the kidney. A nephrotomy was performed, the stone was pulled out of the kidney through the incision and the remainder of the kidney explored (Fig. 290). In another case, that has already been mentioned under Partial Nephrectomy, the stone had been discharged with the pus in the abscess cavity and lay outside of the kidney (Fig. 309).

Calculous Anuria.—When anuria accompanied by pain suddenly develops in a case of nephrolithiasis due to ureteral obstruction by a calculus, an antispasmodic should be given, as morphin and atropin hypodermically, and a mixture containing 15 grains of acetate of potash and 15 minus spts. etheris nitrosi, every two hours, to see if the ureter can be flushed and the obstruction removed. While this process of flushing is under way, it is well to cystoscope the patient and to attempt to catheterize the ureters in order to locate the obstruction. Sometimes the ureteral catheter will prove valuable by encountering a calculus and pushing it back into the pelvis or by controlling a ure-

teral spasm. Where this procedure fails, however, and we have satisfied ourselves concerning the condition of the kidneys and ureters, it is not advisable to wait until uremic phenomena develop, if they have not already done so, before operating, as we know that uremia will set in unless the obstruction is removed and that the operation is usually very effective. The method of choice is nephrotomy, which is readily performed and promptly beneficial through bleeding and removing renal and ureteral tension. The stone or stones may be removed, if met with, by the finger introduced into the renal pelvis or the upper ureter. A prolonged search, however, is not advisable, for the reason that anesthesia is always dangerous in these patients whose kidneys have already ceased to functionate. It is sufficient, therefore, to pass the catheter down the ureter in the hope of freeing the obstruction from above. The pressure having been removed by the nephrotomy, the ureteral spasm ceases and the stone may pass down into the bladder, and if not, an operation for its removal can be performed later. These kidneys are usually very much distended and the gush of blood and urine after the incision is very abundant. I have operated in such a case five days after anuria had set in and when there was no pain and almost no symptom of uremia. The other kidney is usually incapacitated.

The unilateral location of the colics, tenderness on pressure, increase in size of the kidney and ureteral catheterization will serve to indicate the side to be operated on. Where obstruction has been found on both sides, a double nephrotomy may be performed, or, in case this is forbidden by the general condition of the patient, the incision is best made in the side which has been last affected.

There are probably many people who consider themselves healthy and yet have but one functionating kidney, the other having been destroyed through a blocking of the ureter by calculus or a tuberculous infiltration years before; or through a suppurative process that has destroyed the parenchyma. A kidney can have been the seat of a small calculus that gave rise to suppuration and was then passed down the ureter and voided in the urine; after which the suppurative process can have continued until the kidney has been destroyed, or the stone may have remained in the kidney and the organ been destroyed through suppuration. The former explanation seems improbable and yet I believe it can occur and will quote a case to strengthen my belief. The latter I know can occur.

Illustrative Case.—The patient, a contractor, forty-eight years of age, had not passed urine for five days, and a catheter passed into his bladder twice daily had failed to find any fluid there. Five years prior to this time, he had suffered from very severe pain in the right side, lasting for some time and accompanied by fever; he then passed two calculi, after which he felt perfectly well and had considered himself so up to his present illness. When the patient came under observation, there were no uremic symptoms except slight

drowsiness; he had a slight cough and a few sonorous râles. Pain had been present during the first two days of the attack, but had disappeared. Cystoscopy was performed and no urine was found in the bladder. No urine escaped on introduction of a catheter into the pelvis of the right kidney; the left ureter was obstructed just above the bladder wall.

Treatment.—Left nephrotomy with drainage. Two days later the patient began to pass urine by the urethra. The ureters were again catheterized, and the right side was still found to be free, but no urine came away. The left side was now unobstructed, the stone having been passed out, and the kidney was draining again through the ureter into the bladder.

CHAPTER XXIX

TUBERCULOSIS OF THE KIDNEY

Historical Data.—References to strumous and scrofulous kidney occur in early medical literature, and Malpighi is known to have devoted considerable time to the study of the suppurative processes caused by this condition. The actual history of renal tuberculosis, however, is intimately connected with the advancing knowledge of tuberculosis in general, and is therefore relatively brief. Klebs, in 1887, was the first to find bacteria constantly present in tuberculous tissue, which produced similar lesions when inoculated into animals. Five years later, the specific microörganism, the tubercle bacillus, was discovered by Koch. This discovery was followed almost immediately by the demonstration of the bacillus in the urine by Cohnheim.

The work of Koch and Cohnheim, together with other advances in surgical pathology, have enabled us to gain a clear insight into the nature of renal tuberculosis, not only from clinical observation backed by postmortem findings, but also through the experience gained by operating at various stages of the disease.

Tuberculosis of the genito-urinary organs is always secondary to the disease elsewhere, as in the glands, bones or lungs. A primary focus of tuberculosis is said to occur occasionally in the kidney: that is, before any other organ or tissue is invaded. Such cases are, however, so open to question that it is better for us to consider tuberculosis of the genito-urinary tract as a secondary manifestation to a condition elsewhere in the body. Therefore, when I use the expression "primary tuberculosis of the kidney," I mean that the disease is present in one kidney and not as yet in the other. It occurs primarily in one kidney in about fifty per cent of cases. If, however, we use the word "primarily" in the kidney, we will mean before it occurs elsewhere in the body.

Tuberculosis occurs in the kidney more frequently than in any other organ of the genito-urinary tract; in fact, about as often as in all the other organs put together. According to Walker, in a series of 279 cases, the part of the genito-urinary tract invaded first was the kidney in 184 cases, the epididymis in 80, the prostate in 3, the Fallopian tube in 3, the seminal vesicles in 2 and the uterus in 1 case.

It would appear from these observations that tuberculosis of the bladder

is never a primary disease of the genito-urinary tract, but that it is usually secondary to that of the kidney or epididymis; in the first instance descending along the ureter, and in the second invading the bladder through the prostate. Halle and Motz, in one hundred of their own cases, found several in which tuberculosis was present in the renal pelvis and ureter together with an involvement of the kidney on that side and not of the bladder.

Tuberculosis of the kidney is of two forms: The acute or miliary, which is a part of the general constitutional disease, and the chronic form, in which there is a cheesy and suppurative degeneration of the organ, such as we are accustomed to see surgically.

Tuberculosis of the ureter is always secondary to that of the kidney and not to that of the bladder.

The most common age at which tuberculosis of the kidney occurs is between twenty and thirty. In autopsies performed at the Pathological Institute at Prague on adult consumptives, 5.6 per cent were found to have renal tuberculosis. Children are much more frequently attacked than was formerly supposed and in 315 cases of tuberculosis 15.7 per cent had renal involvement. The miliary form is more frequent in children and the chronic or caseous form in adults (Rilliet and Barthez). Eight per cent of my cases were in patients fourteen years of age or younger. This is rather a large percentage in a practice in which nearly all the patients were adults.

Regarding the sex, authorities differ as to whether women or men are more frequently affected. The latest statistics show that it is more common in women. It is more frequent on the right side. In cases that I have studied, 54 per cent occurred on the right side, 28 per cent on the left and 18 per cent on both sides.

Etiology.—The predisposing causes of tuberculosis are, first: A weakened condition of the system, which diminishes the resistance; and second, a condition of the kidney favoring infection, such as a congestion from traumatism or other causes, irritating products in the urine, renal stasis, inflammation of the kidney, renal calculus or undue mobility of the organ. Tuberculosis in the family also renders the patient more susceptible to tuberculosis in general or the kidney in particular. A tuberculous family history was common in my cases.

The active cause is the entrance of the tubercle bacillus into the organ. It is said that tubercle bacilli can pass through a normal kidney, bladder and urethra without giving rise to urinary tuberculosis, but that when the germ finds the proper conditions, such as have been mentioned under predisposing causes, it will remain there and infect the organ.

It has been shown that the tubercle bacillus can reach the urine through the hematogenous and lymphogenous route, or that it can pass upward from the bladder. It is probable, however, that in nearly all cases the bacilli reach the

kidney through the general circulation, and but rarely by the way of the ureter or the lymphatic channels. The ascending theory of infection does not appeal to me, as it is highly improbable that bacilli often work their way upward against the descending current of urine, and I believe that such infection can take place only when certain rare conditions are present.

In regard to the occurrence of primary tuberculosis, some observers state that primary tuberculosis frequently occurs in one kidney; others claim that tuberculosis is never primary in the kidney, but always secondary to that in some other part of the body. Such statements are difficult to understand. It is safer to say that tuberculosis never occurs in one kidney primarily, that is, before it does in any other organ or tissue. This is corroborated by many, who say that there are only five cases of primary unilateral tuberculosis of the kidney on record in which the autopsy showed no other tubercular lesion in the body, and these are questionable.

It, therefore, seems to me that in a clinical consideration of the subject we can sum up these various statements by saying that tubercle bacilli, from whatever source, passing through the renal circulation, by the blood or by the lymphatics, may infect a congested kidney with tuberculosis; that the infection usually takes place in one kidney before it does in the other and that the other kidney will probably not be involved if the diseased one is removed at a sufficiently early date.

As we have already stated, tuberculosis occurs in one kidney in about fifty per cent of the cases, and we generally find it confined to one kidney in that percentage of cases presenting themselves for treatment. Such an opinion is based principally on clinical findings and many surgeons claim a higher percentage of unilateral tuberculosis; but it must be remembered that we cannot always tell whether the second kidney is clinically involved or not, as, during the stage of invasion and development, tubercle bacilli are extremely hard to find in the urine, which contains but few pathological products of the disease. On the other hand, the postmortem examination in renal tuberculosis shows a smaller percentage of unilateral disease, but here we must consider the fact that in such cases the disease is much more advanced than when the surgeon makes his clinical examination.

Secondary suppurative processes in tuberculous kidney are due to infection with pyogenic germs, usually the Staphylococcus aureus, the colon bacillus or the streptococcus. The colon bacillus may enter the kidney through the circulation, or it may ascend from the bladder or may migrate to the kidney from the colon; whereas the other two enter either through the circulation or accompany a mixed infection from below upward.

Pathology.—The two types of tuberculosis of the kidney are the miliary and the caseating. The miliary form occurs particularly in a general tuberculosis and is characterized by the presence of miliary tubercles scattered

throughout the tissue of the organ, often near the surface beneath the capsule, so that they may be seen on inspection before the kidney is cut open. On section, they are often found present in the cortex of the kidney in the shape of small whitish or yellow spots.

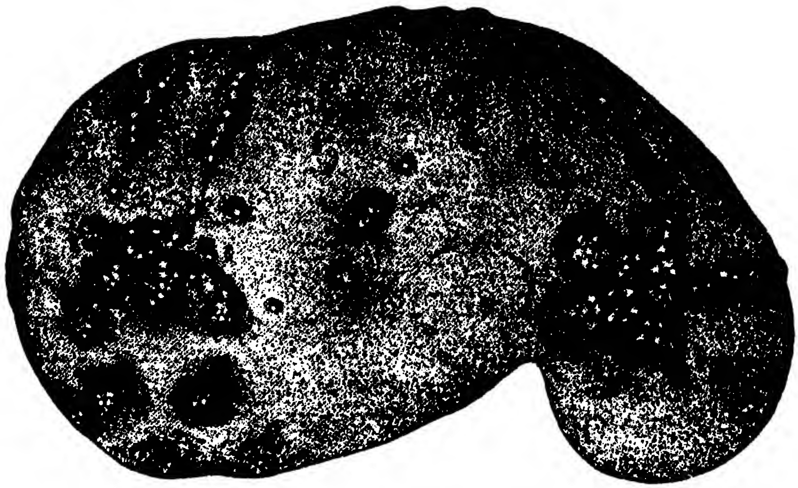


FIG. 310.—CLUSTERS OF TUBERCLES ON THE OUTSIDE OF THE KIDNEY. They appear to be of the miliary type, yet the author has in his collection numerous kidneys with such lesions seen under the capsule which have cavities in their interior three quarters of an inch in diameter. (From Van Bergman.)

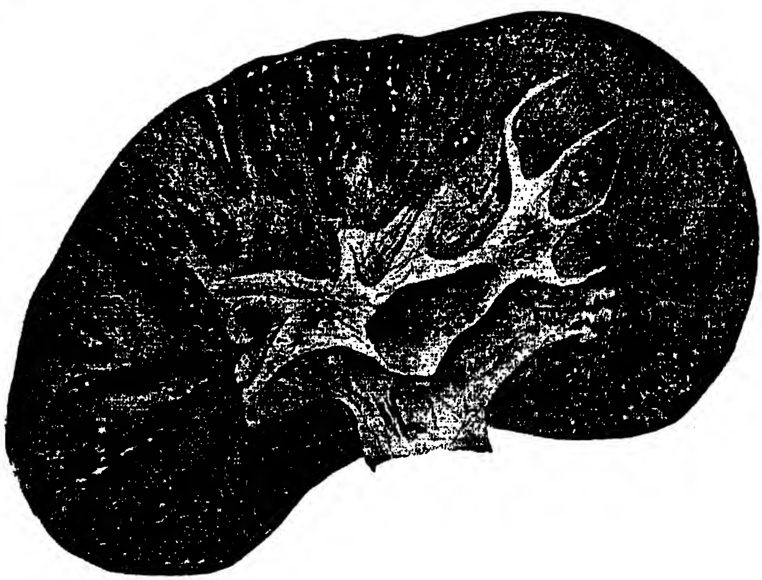


FIG. 311.—THE SAME KIDNEY AS IN FIG. 310, SHOWN IN SECTION. Note the arrangement of the tuberculous deposits. This is the beginning of an acute tuberculosis. The type is miliary, but the result may be great destruction and extensive cavity formation. (From Van Bergman.)

The caseating form is characterized by the presence of grayish or yellowish cheesy nodules scattered throughout the substance of the kidney which is usually

enlarged and slightly nodulated. These nodules are filled with necrosed tissue detritus and are surrounded by interstitial fibrous tissue. The outcome of the process of a pure infection with the tubercle bacillus is in cicatrization and contraction of the scar tissue, sometimes even leading to an occlusion of the ureter, the disappearance of the pelvis and destruction of the kidney parenchyma. Figs. 310 and 311 show clusters of tubercles resembling the miliary type. I have frequently removed kidneys, that I have in my collection, with superficial appearance normal in one pole, whereas in the other pole there were cavities an inch in diameter.

When a secondary infection occurs, due to the entrance of pus-producing germs, the caseating nodules enlarge, suppurate and discharge into the renal pelvis (Fig. 312), or occasionally under the fibrous capsule, in which latter case they may break through it and give rise to a perinephritic abscess (Fig. 286). The renal pelvis is sometimes involved simultaneously with the kidney, but generally later, after infection has taken place and the tubercular cavities have broken into the pelvis; in that case the urine will contain tubercle bacilli and portions of necrotic tissue. A tubercular cavity containing softened matter and pus, sometimes spoken of as a tubercular cyst, may break both into the renal pelvis and through the renal capsule, giving rise to a renal fistula and perinephritic abscess. I have seen such a condition in a number of cases and have been able to pass my finger from without the kidney into the pelvis. When the renal tissue has been more extensively destroyed, the cavernous areas become more marked and are separated by walls of fibrous tissue. (See Fig. 314.)

Fig. 312.—A Case in which the Tuberculous Abscesses Have Broken into the Pelvis, Giving Rise to Pyelonephritis. (Author's case.)

The various forms of disease that we see, after a secondary infection by pus-producing bacteria has taken place, are abscess of the kidney, pyelo-nephri-

tis and pyonephrosis. Abscess of the kidney shows itself as a circumscribed collection of pus and tubercular detritus in the renal parenchyma, usually the cortical portion, which may or may not break into the renal pelvis. Pyelonephritis is a condition occurring when the nodules, after infection, soften, liquefy

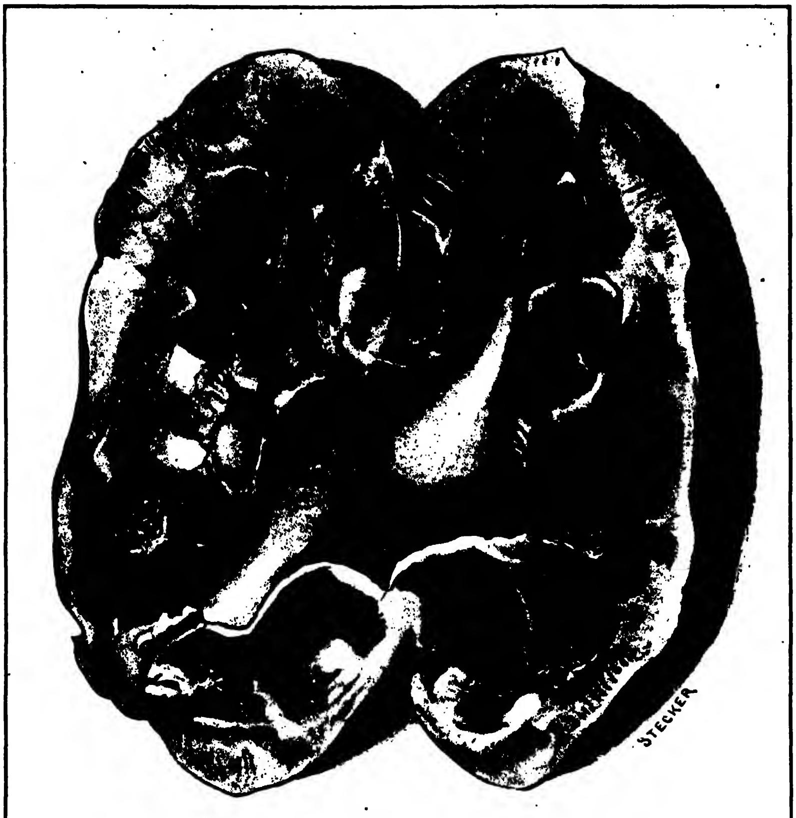


FIG. 313.—PYELONEPHRITIC KIDNEY 6 INCHES LONG.
Note the pus cavities, especially in the lower pole. (Author's case.)

and discharge into the pelvis, leaving a tract leading to a pus cavity. Pyelonephrosis or pyonephrosis is a phase of pyelo-nephritis in which many abscesses have discharged into the pelvis, and the kidney parenchyma consists of a number of pus cavities, discharging into the pelvis, separated from one another by fibrous walls. A thickened or strictured ureter may also give rise to urinary and pus retention, with a dilated pelvis and destruction of the parenchyma by pressure and suppuration, constituting another form of pyonephrosis. Figs. 313 and 314 are two kidneys from the same patient. Fig. 313 is a pyelonephritic kidney and Fig. 314 is a pyonephrotic kidney.

A ureter may be occluded by a tuberculous thickening of its walls, in which case there is usually a dilatation behind it; or, if the process is more complete, it may be converted into a fibrous cord. If such a change takes place, the cor-

responding tuberculous kidney may develop, in consequence of ureteral occlusion, a pyonephrosis depending in size upon whether the occlusion has taken place rapidly or slowly. Fig. 315 is a specimen removed at autopsy from an inoperable case of urinary tuberculosis on my service at the Columbus Hospital. The tuberculous process had entirely occluded the right ureter, giving rise to an atrophic kidney, whereas, on the left side, it but partially occluded the ureter, causing pyonephrosis and renal enlargement.

The appearance of the two kidneys in this form of tuberculosis may differ greatly macroscopically, as in the same case we may have the following conditions: One kidney healthy, the other larger or smaller than normal, in any stage of involvement or degeneration. If both kidneys are involved, one may be in-

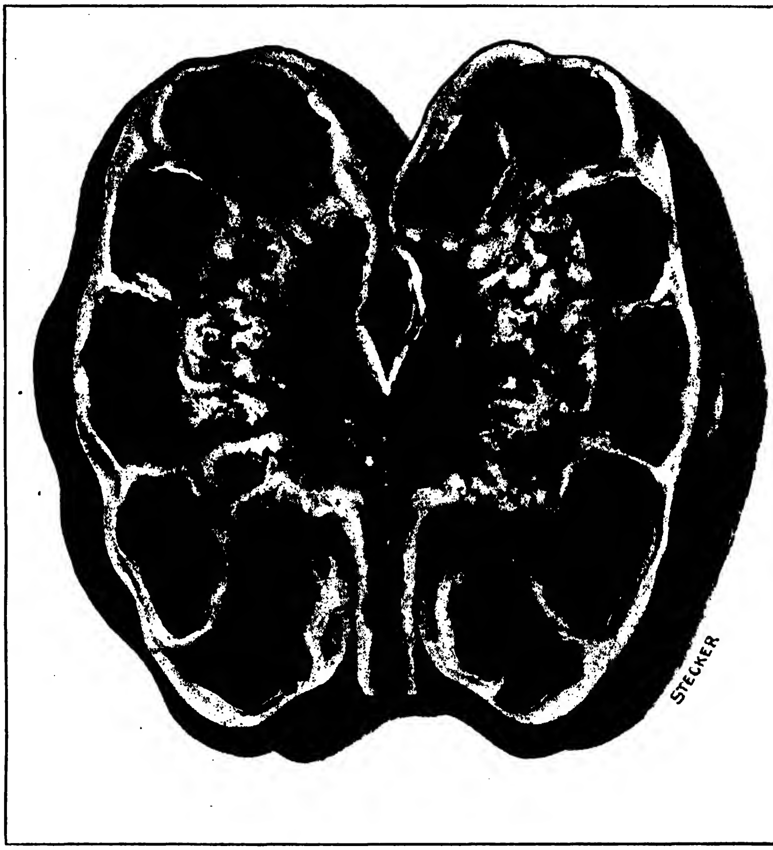


Fig. 314.—Pyonephrotic Kidney 7 Inches Long. Note the large cavities in all parts of the organ separated by septæ; also the thickened pelvis and ureter. (Author's case.)

fected with the tubercle bacillus alone and the other by both tubercle bacilli and the germs of suppuration (mixed infection); in other words, one side may be undergoing a nonsuppurative, caseous degeneration and the other kidney both a caseating and suppurative process.

One kidney may be in a state of pyelo-nephritis and the other in a state of pyonephrosis. Usually, if both sides are involved with a mixed infection, it is a pyelo-nephritis. In case of a pyonephrosis on one side and a pyelo-nephritis on the other side, the pyonephrosis is usually a slower process, less acute, with

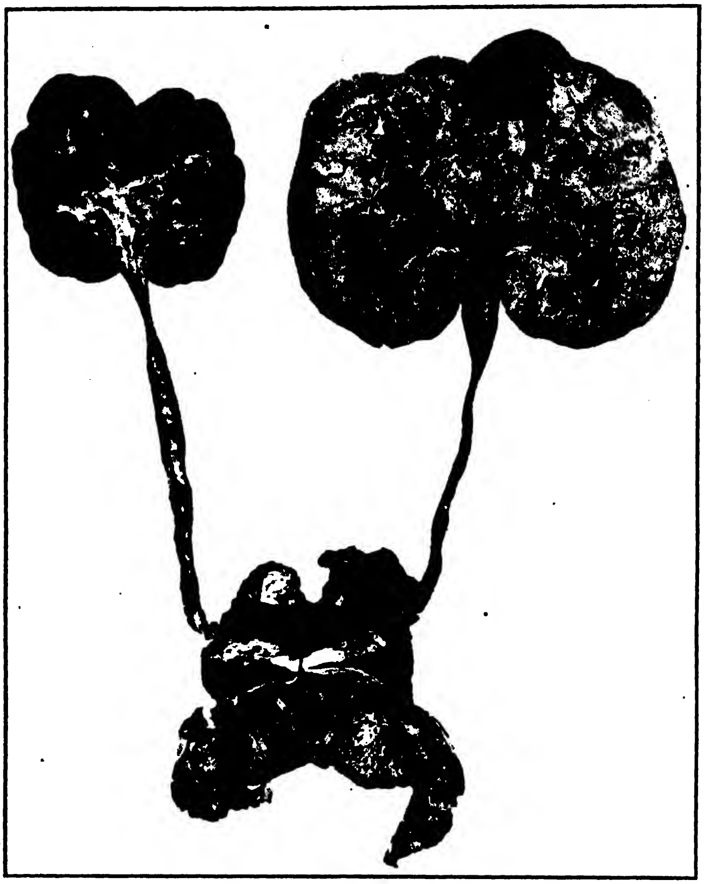


FIG. 315.—A CASE OF URINARY TUBERCULOSIS INVOLVING BOTH URETERS AND BOTH KIDNEYS. On the right side the ureter became rapidly imperforate, due to a stricture near the kidney and to a tuberculous thickening near the bladder, with a consequent atrophy of the corresponding kidney; size 3¾ inches. On the left side, the occlusion of the ureter was slow and incomplete, resulting in a large, thickened kidney with pyonephrosis; size 7 inches. (Author's case.)

ureteral thickening; the kidney itself is larger than the pyelo-nephritic kidney on the other side, which is more acutely inflamed. In the case of pyonephrosis of both sides, one organ is usually larger than the other and this is the kidney whose ureter is not so much thickened by the tuberculous process. (See Fig. 315.)

A tuberculous kidney may be in any condition from being the seat of a single small nodule to such extensive degeneration that the functionating tissue of the organ is entirely destroyed, only a fibrous tissue mass or a shell remain-

ing (Fig. 316). Both kidneys may be in the first-named condition without giving rise to clinical symptoms; whereas such a grave change as the one referred to in the second instance, occurring in but one organ, would be incompatible with life, unless the other kidney was perfectly healthy.

These changes in size, shape and appearance of the kidneys depend upon the rapidity or slowness of the process, the amount of thickening or stricture formation in the ureters, the presence of areas of cheesy degeneration or of abscesses, the amount of kidney tissue that has been destroyed, the presence of single or mixed infection and the variety of mixed infection.

Various lesions may be found associated with those of renal tuberculosis, as calculi or neoplasms; the perinephritic tissue may be the seat of sclerotic,

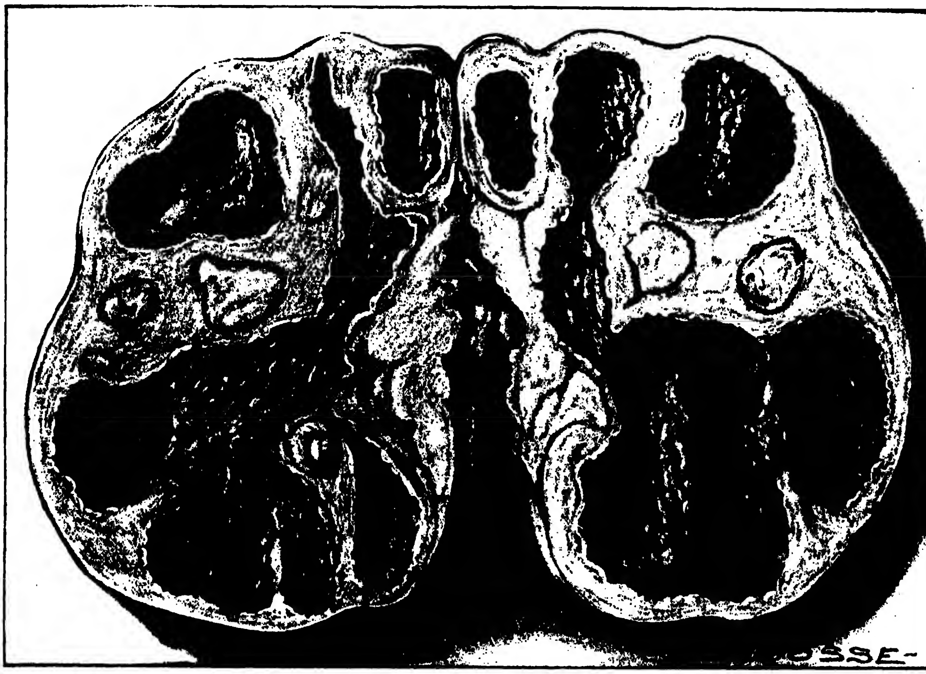


FIG. 316.—TUBERCULOUS KIDNEY IN WHICH THE FUNCTIONATING RENAL TISSUE HAS BEEN ENTIREL DESTROYED BY THE DISEASE. (Author's collection.)

suppurative or lipomatous changes, and the lymph nodes of the hilum may participate in the tuberculous process. The bladder may be the seat of tuberculosis before or after the invasion of the kidney. The male genital apparatus may be infected at the same time; but tuberculosis of the generative organs is much less common in women and usually located in the tubes when it does occur, which is only about one sixth as often as in the male.

Symptoms.—Acute cases of renal tuberculosis are of the miliary type and occur in persons suffering from the general form of the disease, and this is a condition which concerns the physician rather than the surgeon. The form

of renal tuberculosis that the surgeon is usually called upon to treat is the chronic or caseating variety. It begins insidiously in the majority of cases and it is said by some that it may not show itself by any clinical manifestations for years, or perhaps never during the lifetime of the patient; while others say that an ordinary case will only live three years after its first evidence. I think it safe to say that renal tuberculosis will show symptoms in less than a year in nearly every case. The symptoms may be so slight, however, as not to be recognized, as, for instance, in cases where one or two caseating nodules occur in one kidney in a patient whose resistance is sufficient to overcome the disease; in this case the nodules will become encapsulated and the process arrested.

The duration of the disease in the patients coming to me for treatment, estimated on the basis of symptoms, had been from four days to four years, with an average of fifteen weeks.

The symptoms of tuberculous kidney are subjective, objective, general and local. The reflex symptoms in this disease may lead one away from the affected region to look for the cause in other directions, the same as in nephrolithiasis; for here we have also the reno-vesical reflex by which the symptoms are referred to the bladder instead of to the kidney, and also the reno-renal reflex in which the symptoms are referred to the healthy or healthier kidney.

Subjective symptoms	Pain in the loin. Pain in the bladder. Tenesmus. Burning. Frequency of urination (pollakiuria).
Objective symptoms	Increased amount of urine (polyuria). Hematuria. Pyuria.
General symptoms	Fever. Sweating and chills. Loss of appetite. Loss of weight and strength.
Local symptoms (found on examination)	Tumor. Abdominal tenderness; muscular rigidity. Swelling or suppuration of glands, genitals, bones, joints or elsewhere. The results of such involvements as pointed out by sinuses, scars or deformities.

SUBJECTIVE SYMPTOMS.—*Pain in the Loin.*—In many cases there is no local pain. When present, pain in the loin is generally dull in character, al-

though it is severe when the process is acute and attended by much congestion. After the first stages of tuberculosis of the kidney, when the organ has been extensively destroyed, the pain is not so severe as while the inflammation is more acute and there is consequently more tension in the organ. However, during the destructive process, when masses of necrosed tissue are being passed down the ureter, a renal colic may take place, leaving the kidney free from pain after it has subsided.

The pain may be in the kidney that is the least involved if the inflammation is more acute on that side; or it may be in a healthy kidney if additional work is suddenly thrown upon it. This is probably the explanation of what is known as the reno-renal reflex.

The following statistics are from the records of cases that I have had under observation.

PAIN IN THE KIDNEY: Eighty-three per cent had pain, seventeen per cent had no pain.

CHARACTER OF PAIN:

Pain in the loin—more or less steady	43	per	cent.
Pain increasing gradually	4	"	"
Pain and muscular rigidity	18	"	"
Double pain	4	"	"
Pain on exercise	7	"	"
Renal colic	7	"	"
Total	83	"	"

Pain in the bladder, that is, in the perineum or suprapubic region, may be the most marked and constant symptom associated with renal tuberculosis and nearly always occurs when the pathological process exists in this viscus. Vesical tuberculosis is very frequent and should always lead us to investigate the kidneys, even if there is no pain or other symptoms in those organs. Twenty-five per cent of the cases above referred to had vesical pain.

Tenesmus is a symptom in almost all cases of reno-vesical tuberculosis in which there is bladder pain, as is also burning on urination and frequent urination.

Frequency of urination may occur for two reasons, first on account of the bladder irritation when the tuberculous process has invaded it, and secondly on acccount of the greater amount of urine which is secreted from the tuberculous kidney. This frequency is noted during both the day and night and when due to vesical tuberculosis is apt to prove very fatiguing, the patient's sleep in certain cases being very much interrupted by the frequent calls to pass urine. When frequency occurs in connection with pain and tenderness, it is not due to an associated reno-vesical reflex, as was formerly supposed, but to an asso-

ciated tuberculous cystitis. The amount of such frequency depends upon the seat of the tuberculous lesion in the bladder, being the greater the nearer the lesion is to the neck of that organ or to the sphincter muscle. This I proved conclusively by cystoscopic examinations.

Objective Symptoms.—*Polyuria* is a very common and important symptom. The urine is of low specific gravity and closely resembles that of interstitial nephritis, being often diagnosticated as such.

Hematuria is also a frequent symptom. The blood is generally thoroughly mixed with urine, although sometimes it is passed as ureteral clots, which are long and slender. It often occurs suddenly, without cause, and disappears in the same way. It is not induced by motion or jarring. Sometimes the hematuria is more constant, there are no ureteral clots, and the blood is more thoroughly mixed with the urine. Besides this, the hematuria is often accompanied by frequency of urination and tenesmus, in which case it is referable to tuberculous lesions in the bladder. Blood in the urine may be the only local symptom of renal tuberculosis during the early stages, before suppuration has begun. This condition in tuberculous kidney is sometimes compared to hemoptysis in the pulmonary form of the disease. There was a history of hematuria in fifty per cent of the cases under observation.

Pyuria is a frequent symptom and does not occur until a secondary infection has taken place. This is usually due to the staphylococcus or the colon bacillus, or in the more acute cases to the streptococcus; generally it is not until pus appears that the tubercle bacilli are found.

General Symptoms.—Among the important general symptoms are loss of appetite, strength and weight. The last is very important, as it is often a measure of the invasion and rapidity of its progress.

Fever.—The temperature change of renal tuberculosis may be slight, as from normal in the morning to 99° F. in the evening; or it may run from 102° to 105° F., or any degrees between these figures, depending upon the variety of the secondary infection. Of my cases, forty-five per cent had a temperature before operation varying from 98.4° to 99° F. in mild cases and from 100° to 105° F. in serious cases.

Sweating and chills are signs of secondary infection and the absorption of pus after the suppurative processes have begun. In this stage, the *loss of weight and strength*, as well as *of appetite*, may be very marked.

Diagnosis.—Examination.—Palpation of the loin may reveal an enlargement of the kidney, abdominal tenderness or muscular rigidity.

The presence of a *tumor* in the loin, that is, a palpable kidney, is frequent during the stage of caseation and still more so after secondary infection has taken place and a pyelo-nephritis or pyonephrosis has developed. The absence of an appreciable tumor, however, does not argue against the existence of a tuberculous kidney, as it may not be outlined owing to muscular rigidity; or

in the stage of pyonephrosis it may be so destroyed as to be smaller than a normal kidney; or it may be large, but so soft and pliable that it cannot be outlined. The kidney shown in Fig. 313 is smaller than its mate, while in Fig. 314 the kidney is very large but so soft that it could not be outlined until the patient had been anesthetized.

Tenderness over the kidney is often present and at times extreme. It can be best detected by deep pressure on the kidney between the fingers of one hand on the abdomen and of the other hand behind, just below the twelfth rib. At times, there is tenderness anteriorly on surface palpation, when the kidney is acutely inflamed; in this case, the kidney of that side may not be so seriously involved as the other organ, but more acutely inflamed. *Muscular rigidity* is also often present over the kidney on the anterior abdominal wall, the same as over the appendicular region in case of appendicitis.

In suspected cases of renal tuberculosis, tuberculous manifestations of the lungs, the glands, the joints or the genitals are corroborative of its presence; while a history of such involvements in the past, as well as the presence of scars, deformities or sinuses, is suggestive.

Urine.—The urine in tuberculosis of the kidney at times gives no indication of the disease to the casual observer until it becomes purulent and then, if bladder symptoms are present, it may point to a cystitis rather than to the kidney.

The urine of tuberculosis of the kidney may be divided into three varieties: That of the stage of invasion, of development and of destruction.

During the period of invasion, the urine resembles that of renal congestion of varying degrees. It may show albumin, red and white blood cells, renal and pelvic epithelia, hyaline casts and a variable specific gravity.

During the stage of development, which corresponds to that of formation of tubercular foci and their caseation, together with an increase of interstitial tissue, the urine resembles more that of an interstitial nephritis; that is, a larger quantity, of a lower specific gravity, with a trace of albumin, a few hyaline casts and renal epithelia.

During the stage of destruction, after a secondary infection by pus-producing germs has taken place, the urine resembles that of nephritis plus pus; that is to say, it is light in color, of a low specific gravity and may contain renal epithelia, pus, hyaline, granular, epithelial and pus casts and tubercle bacilli. As tuberculosis of the kidney is so frequently associated with a similar condition of the bladder, pus, blood and vesical epithelia coming from that organ may be also added to the general urine.

The urine sent to the laboratory during the stage of development of renal tuberculosis will generally be diagnosticated as that of interstitial nephritis; or if a cystitis is present, as cystitis and interstitial nephritis. No search for the tubercle bacilli will be made unless especially requested. Again in this stage,

if a search for the tubercle bacillus be made, it probably will not be found, as its demonstration is exceedingly difficult unless the kidney is in the suppurative stage.

When the suppurative stage has set in, the diagnosis from the laboratory often comes back as cystitis and pyelo-nephritis. It is, therefore, very important in sending urine to a urinologist to accompany it by a short clinical history, stating that tuberculosis is suspected.

Tubercle Bacilli.—Notwithstanding the fact that there are probably tubercle bacilli in the urine, it is extremely difficult to find them in reno-vesical tuberculosis. I have seen typical tuberculous ulcers in the bladder, with involvement of both kidneys, and yet no tubercle bacilli could be found by some of the best New York urinologists until several examinations had been made. It is very important to have the tubercle bacillus differentiated from the smegma bacillus, as it is extremely disheartening after specimens have been examined for many days at a considerable expense to the patient, to have a laboratory man say that he has found some bacilli closely resembling tubercle bacilli, but that they may be smegma bacilli. While the morphological distinction between the two is not easy, the identity of the tubercle bacillus can be usually established by treating with alcohol a specimen stained with carbol-fuchsin. The smegma bacillus becomes decolorized, while the tubercle bacillus retains the red stain.

An aid to the finding of tubercle bacilli is to produce artificial polyuria and collect the urine in a large tapering beaker, so as to be able to pour off the top and to have an abundant deposit in the narrow bottom. Frequent examinations should also be made—as often as several times a week if necessary. In this way it is probable that, in eighty per cent of the cases of tuberculosis of the kidney, the bacilli will be found in the urine. A clinical diagnosis, however, based upon the findings already mentioned together with an exclusion of other diseases whose symptoms resemble renal tuberculosis, is usually correct and accepted.

Guinea-pig Inoculations.—Guinea-pig inoculations are very important and should be resorted to as soon as tuberculosis of the kidney is suspected, as much time is often lost in making urinary examinations. Patients also begin to distrust their advisers if they are made to wait too long for an opinion, besides which many do not feel like paying for the numerous urinary and cystoscopic examinations. I have lost a number of interesting cases through numerous examinations of the bladder and urine before finally resorting to animal inoculation, whereas, if I had used guinea pigs immediately, I would have known quite as soon of the presence of tuberculosis.

It is said that the pigs should be tested with tuberculin before they are inoculated. The inoculation should be performed with the same antiseptic precautions as an operation. The hair should be shaved from the abdomen;

the sediment, diluted with normal salt solution, should be injected into the peritoneal cavity, or, better still, into the glands of the groin. The guinea pig should be well fed and weighed every few days. If at the end of six weeks the animal is still alive, it should be killed with chloroform, the autopsy performed and a search for tubercles made in the peritoneal, mesenteric and inguinal glands.

Tuberculin Test.—Final resort may be had in the tuberculin test. Robert Koch prepared a fluid from cultures of the tubercle bacillus which contained the glycerin extract of the bodies of the germs. A subcutaneous injection of this fluid, at a minimum dose, produces fever if tuberculosis exists in the body. A large dose may give rise to a febrile reaction in health. While a positive result is a very strong evidence of an active tuberculous lesion, a negative result is not quite so valuable, as in a certain number of old encapsulated lesions, notably tuberculous peritonitis, a positive reaction does not occur even after quite large doses.

Personally, I never use the tuberculin test.

The Cutaneous and Ophthalmo-reaction Tests.—The diagnostic methods recently proposed by Von Pirquet and by Calmette are based on the local reaction that follows the application of tuberculin to the skin in the former and conjunctiva in the latter of tuberculous individuals. Opinions are divided as to the practical value and the harmlessness of these procedures.

In a general way, it may be said that, wherever there is a choice of several diagnostic methods, the simplest and safest should always receive the preference. Animal inoculations seem to meet the indications most efficiently.

Cystoscopy.—Cystoscopy is often of great importance in the diagnosis of renal tuberculosis, as a cystoscopic diagnosis of vesical tuberculosis points to the probability of renal involvement. It is said by some that vesical tuberculosis is always associated with, or secondary to, renal tuberculosis, and some say that the removal of a diseased kidney will cure a vesical tuberculosis. This I do not believe, as my clinical experience has not corroborated it. In cases of tuberculous cystitis, the bladder symptoms are often sufficient to mask completely those of the kidney if it is diseased. At other times, the bladder symptoms are very mild.

Tuberculous lesions about the mouth of the ureter should make us suspicious of tuberculosis of the kidney on that side; in fact, so much so that in the absence of all other symptoms and after repeated failures to find the tubercle bacillus in the urines, I have operated on kidneys with lesions about the ureteral mouths on that side and found them to be tuberculous.

There is a class of cystitis spoken of as hemorrhagic. These cases are usually due to tuberculosis or tumor; nearly always, I believe, to the former in young people whose bladders are very sensitive and are spoken of as contracted. The organ is, however, probably only in a state of spasmodic contraction, on

account of being oversensitive. It is often impossible to cystoscope such bladders satisfactorily, as they may not retain more than an ounce of solution, although they have been quite capacious but a short time before. Even when sufficiently anesthetized for any operation, they still remain spasmodic. A higher degree of anesthesia would relax the vesical spasm, but would be dangerous to the life of the patient.

Ureteral Catheterization.—Ureteral catheterization by means of a catheterizing cystoscope is of treble value, as in this way we see the condition of the interior of the bladder, whether or not tuberculous lesions are present and, if present, where they are located. The presence of both kidneys can be determined and a specimen obtained from each, which will allow us to judge their comparative functional capacity. In case one ureter can be catheterized and not the other, although it is possible to see the ureteral mouth and urine coming from it, we can drain the catheterized kidney with the ureteral catheter, and the other kidney which cannot be catheterized, by leaving an ordinary soft-rubber catheter in the bladder after the cystoscope has been removed and the bladder emptied, and in this way collect the two specimens. If we cannot find the mouth of the second ureter, or if, on the other hand, we can find it and the catheter will not enter and no urine is seen to come from it, then an incision should be made through the loin on that side to ascertain if there is a kidney there and to judge of its condition.

In one case of so-called hemorrhagic tuberculous cystitis in which not sufficient fluid could be introduced into the bladder to see the ureters, even under an anesthetic, and yet I could palpate a large pyonephrotic kidney on the right side but could not feel the left, I opened the peritoneal cavity to make sure of the presence of another kidney and palpated what appeared to me a normal organ on the left side before performing nephrectomy on the right. I do not believe that the exploratory laparotomy was a good surgical procedure, however, and in the event of another such case I would make an exploratory lumbar incision.

Sometimes it is difficult or impossible to see the bladder sufficiently well to examine its walls and to find the ureters, on account of the turbid fluid medium. Consequently, after the bladder has been washed for some time and the fluid has become quite clear, if on refilling it prior to the introduction of the cystoscope, the contents are found to be cloudy again, it points to a hydronephrotic kidney on one side that has again emptied itself. It is well, therefore, to press upon the kidneys on both sides in order to squeeze out the residual urine and then to empty and refill the bladder quickly in order to see the ureter.

In catheterizing ureters to determine the condition and function of each kidney, we must note the rapidity with which the urine flows from each side. Each kidney should secrete about an ounce an hour, corresponding to twenty-four ounces for each twenty-four hours, or forty-eight for both. The diseased organ

often secretes more than the healthy one. In one of the cases in which I performed nephrectomy, at least three fourths of the kidney were found to be destroyed, although the organ had secreted four times as much urine as the healthy one; but the fluid coming from it was composed principally of water and pus, with a very low specific gravity. If one kidney suddenly secretes a large amount of turbid white urine after the introduction of the ureteral catheter and the other secretes slowly a normal amount, it would seem to show that there is renal retention on one side and, consequently, a pyonephrosis accompanied by considerable renal destruction. In one of my cases, three ounces of turbid urine of a milky color and low specific gravity escaped immediately from a kidney, the parenchyma of which was almost entirely destroyed.

Sometimes a large lump of pus is seen hanging from the diseased ureter and at other times thick pus comes down slowly through the ureteral catheter into the bottle in a semisolid mass, showing that there is practically no liquid secreted on that side. Such a condition is rare and points to the presence of a nonfunctionating kidney or one that is a fibrous pus sac practically out of commission, or to a perinephritic abscess.

Having collected the amount of fluid from each side, it should be measured, its specific gravity taken, the amount of urea tested, the side containing the pus noted, as well as the amount, and the quantity of albumin, blood and the variety of casts considered. The urine from both sides should be tested for tubercle bacilli and injected into guinea pigs. The character of the urine from the healthy, or relatively healthy, side compared with that of the general urine will give us an idea if the healthier organ will be able to carry on the renal function after the removal of the diseased one. In other words, we should determine if there is present in the kidney to remain an amount of normal renal tissue corresponding to one half or one third of the total renal tissue when in good health, before recommending the removal of the diseased organ.

The methods of determining the renal function are the same that have been considered in the chapter on the Examination of the Kidney.

Differential Diagnosis.—The diseases for which tuberculous kidney is most frequently mistaken are:

1. Renal calculus.
2. Renal tumor.
3. Hemorrhagic nephritis.
4. Suppurative diseases of the kidney, due to urinary obstruction or to acute infectious nephritis.
5. Movable kidney.
6. Cystic kidney.

Renal Calculus.—Renal calculus resembles this condition more than any other. The principal points of differentiation lie in the history. On the side

of calculus there may be the presence of gout, rheumatism or lithemia in the individual or in the family; while the anamnesis or the family history may be in favor of tuberculosis. In renal calculus, the lumbar pain is more severe, frequent and colicky, usually following upon exercise, jolting or any muscular exertion. Bladder pain, tenesmus and frequency of urination are not so often present, as there is usually no vesical involvement. Abdominal tenderness and muscular rigidity are less frequent. Hematuria occurs more often after exercise and jolting and is generally more marked than in tuberculosis, whereas pyuria is usually not so frequent or pronounced. The loss of weight, strength and appetite are not so frequent, so constant, nor so progressive as they are in renal tuberculosis. Fever, chills and sweating may occur as an attack when the stone blocks the ureter in cases of pyonephrosis, or more continuously in pyelonephritis, but never as constantly as in renal tuberculosis after infection. The urine may show crystals mixed with mucus and pus, but no tubercle bacilli. There would probably be no evidence of inflamed glands, joints or genitals, either in the history or in the physical examination; nor would there be any nodular or suppurating lesions of the epididymis or prostate.

Radiography is important in studying a case of suspected renal tuberculosis to differentiate it from renal calculus, as the two diseases resemble each other so closely. In such case, the findings of calculus by the X-ray would argue against the presence of tuberculosis, although renal tuberculosis and calculus do sometimes exist in the same kidney. In a recent kidney case sent to me as one of calculous nephritis, the patient had passed two small calculi in his urine some time before, accompanied by hematuria and slight renal colic, and still complained of pain in the loin on that side. Ulcerations seen about the ureteral orifice in cystoscopy, led me to believe that it was tuberculous; the X-ray examination was negative and the guinea-pig test showed the presence of tubercle bacilli. This was four years ago; the patient refused to submit to an operation and has been able to carry on his work since then. The kidney is probably undergoing gradual destruction, or the process has stopped.

It may, therefore, be said that in a suspected case of renal tuberculosis, positive findings of calculus with the X-ray argue against renal tuberculosis; negative findings argue in favor of it. It may also be said that positive findings with guinea-pig inoculations in renal tuberculosis correspond in importance to positive findings with the X-ray in suspected cases of renal calculus in that they are both corroborative evidence.

Renal Tumor.—In cases of renal tumor, the pain is less severe or absent. Bladder pain, tenesmus and burning are absent, as well as loin tenderness and muscular rigidity. The patient is usually over forty years of age. Urination and pyuria are less frequent and severe. Hematuria is more frequent and more severe. Loss of weight and appetite progress much more slowly. Fever and sweating are usually absent. The tumor is generally marked and can be easily

outlined. Varicocele is often present when the tumor is situated on the left side. No tubercle bacilli are found in the urine, but fragments of tumor and atypical cells are frequently present and blood cells are fairly constant.

Hemorrhagic Nephritis (Unilateral).—The pain may be more severe, moderate or absent. There are no bladder symptoms, local tenderness or muscular rigidity. There is no frequency of urination and pyuria is absent, as well as fever, chills and sweating. Hematuria varies in severity and frequency in individual cases. Loss of weight, strength and appetite are not so marked, and are proportionate to the loss of blood and the nephritis. No tumor can be felt. The urine shows merely the evidence of a nonsuppurative nephritis and blood. Tubercle bacilli are not present in the urine.

Suppurative Diseases of the Kidney.—Such conditions, not occurring as a complication of stone or tuberculosis, are generally due to an obstruction lower down in the urinary tract, a stricture, an enlarged prostate, a calculous cystitis or a vesical tumor giving rise to either an ascending or a hematogenous infection. The pain may be the same and the patient may also run a temperature and have sweats from the renal sepsis. The kidney may be enlarged and tender on pressure. Loss of weight, loss of appetite and emaciation may also accompany it and the urine may contain the same inflammatory products as in pyelo-nephritis or pyonephrosis, minus the tubercle bacilli. The regular routine examination of the urethra, prostate and bladder, together with the history of the patient, will tell us if the disease is due to urethral, prostatic or vesical involvement. In some cases of renal infection, the gonococcus can be found in the urine from the diseased kidney by ureteral catheterization, but such cases are rare. I have found only four cases of gonorrheal kidney complicating urethritis in my practice of twenty years. Pyelo-nephritis resulting from gonorrhea is in almost every instance due, not to the gonococcus itself, but to some other pus-producing germs that are present in the urethra, and occurs only when the kidney is predisposed to infection. Hematuria is not so frequent in suppurative disease of the kidney and it is rarely that either abdominal tenderness or muscular rigidity is as marked as in certain tuberculous cases.

Movable Kidney.—The pain, if present, is in the loin and is more severe at times when a Dietl's crisis occurs, while at other times it is less than in renal tuberculosis. Urination is less frequent, but it may be irregular in such a way that the frequency is diminished and the quantity lessened when the kidney is out of place, if hydronephrosis is present. It is followed by a gush of urine, increased in quantity, when the organ rights itself. There is no hematuria. In the presence of infection of the renal pelvis, pyuria occurs, but it is usually less severe than in a case of tuberculosis of the kidney. Loss of weight, strength or appetite is not rapid or marked. Fever, sweating and chills are rarely present, unless the kidney is infected, which is not often the case. The urine is

generally less changed, but it may very closely resemble that of the early stages of development in tuberculous nephritis. It rarely contains as much pus as in the last stages of tuberculosis. The kidney can usually be felt as movable. It is generally not as large as in tuberculosis of the kidney, although it may be larger at times if there is retention of urine in the organ, which condition is rarely constant. Tuberculosis has been observed in movable kidneys.

Cystic Kidney.—Cystic kidney is usually larger when seen, more easily outlined and more irregular in its contours than tuberculous kidney. The conditions are very rarely confounded, as renal cysts are not common and tuberculous kidneys resembling cysts are exceptional.

Treatment.—General Considerations.—The general treatment of tuberculosis affecting the kidneys is that of all tuberculous conditions, namely, hygienic, dietetic and medicinal. Patients may also be sent to a climate which is particularly favorable for the disease. These measures are all that can be taken safely, if a marked general tuberculosis exists, as is often the case when the renal trouble is a secondary involvement, or if the opposite kidney is not in a fairly healthy condition. The details of the medical treatment will be considered more in detail after the consideration of the surgical part, which is the more important.

It is said that the ordinary case of renal tuberculosis will live only three years after the first well-marked symptoms, and that the patient, if let alone, will die of cachexia and uremia. I believe, however, that there are many patients suffering from renal tuberculosis who recover without operation and that, when we are more familiar with the disease, this will be shown to be true.

In looking back, we find the following statements that will give us a better idea of the views on the treatment of this disease during the last twenty years.

Epstein, in Ziemssen's Encyclopedia, 1877, says that all treatment is apparently hopeless.

In 1885, Gross collected 20 cases of nephrectomy for strumous kidney from the literature, in which there were 12 recoveries and 8 deaths. In 6 of the cases, but one kidney was involved. In cases in which nephrotomy was previously performed, it had been of no benefit, so he advised immediate nephrectomy whenever possible.

In 1891, Madelung collected 60 cases of nephrectomy from the literature. He concludes that the operation is indicated when the process is to be found only in one kidney.

Willy Meyer, in 1896, said that a tuberculous kidney was almost always at first unilateral and that the infection descended to the bladder. He pointed out that cystoscopy shows the mouth of the affected ureter to be involved and advocated the early extirpation of the diseased kidney.

In 1897, Senn recommended nephrectomy in the case of a tuberculous kid-

ney when the surgeon can prove the presence of a healthy organ on the other side.

In 1904, Krönlein said that he regarded nephrectomy for tuberculosis of the kidney as one of the most successful operations in surgery.

Bevan, in 1907, wrote that tuberculosis of the kidney occurs primarily in one kidney in ninety per cent of the cases and that it is the duty of the general practitioner to diagnosticate the cases early and for the surgeon to operate them early, as a timely operation holds out a good prospect for a cure.

According to Israel, early operations are the keynote to a successful outcome after an early diagnosis and have diminished the mortality more than the functional tests, etc.

Rovsing insists that every tuberculous kidney, no matter how limited, requires removal of the organ, as long as the other kidney is healthy.

Kelly says that no time should be lost with expectant treatment. He favors the removal of the kidney whenever possible, but he incises the kidney sometimes before removing it. The ureter is removed down to the bladder, or perhaps with a piece of the bladder wall.

Von Bergmann says that the kidney should be removed whenever tuberculosis is found. Bilateral infection he considers as very rare.

With this array of evidence it would seem that, in almost all cases of renal tuberculosis, one kidney is primarily involved, and that the only way to save the patient is to remove the diseased kidney before the other side becomes affected.

Krönlein and Israel found that but 3 per cent of cases of renal tuberculosis were bilateral, while Von Bergmann found both kidneys involved in but 1.9 per cent; yet in postmortems it is found that over 60 per cent of the cases are bilateral. Such discrepancies can only be accounted for on the ground that one kidney is involved first and the process is sufficiently far advanced to be detected before the other has become affected; that one diseased kidney but not the other is far enough advanced to allow the diagnosis; or, in autopsy cases, that the patients died because no operation had been performed until both kidneys had become sufficiently diseased to cause death. I may say here that some of the best specimens of advanced renal tuberculosis that I have seen were at the autopsies of cases dying of pulmonary tuberculosis in which there had been no subjective symptoms of renal trouble.

I believe that, in a large percentage of the kidneys removed, the other kidney is involved, but that the involvement is not sufficiently advanced at the time for us to find tubercle bacilli unless animal inoculation is resorted to, which in the past has been little practiced. If guinea-pig inoculations with the urine from each kidney are not made, we must rely principally on our urine analysis and functional tests to determine the condition of the second kidney.

Operations are contraindicated in patients with diabetes, weak heart, diseased arteries, marked general tuberculosis, or when the other kidney is involved; but are indicated in patients with tubercular bladders, which can be treated locally.

Operative Treatment.—The surgical treatment of renal tuberculosis consists of the following procedures: Nephrotomy, nephrostomy and partial or total nephrectomy. Sixty-seven per cent of my cases were operated on; the remainder either refused operation or were not considered favorable for surgical interference. Nephrectomy is the operation of choice and should always be advised if the other kidney can carry on successfully the renal function. Most of my cases were operated on by nephrectomy.

Nephrotomy may be performed for drainage purposes in cases of renal retention of pus and urine and in cases of pyelo-nephritis with abscess formation. It may be followed later by nephrectomy, provided the other kidney functionates sufficiently to allow the removal of the diseased organ. If, however, after the pus has been evacuated from the tuberculous kidney and it has been drained for a few days, its fellow is found not to functionate sufficiently well to allow a secondary nephrectomy, the wound should be allowed to close again. In my own experience, it is comparatively rare for a leakage from tuberculous kidneys through the loin to stop quickly after a nephrotomy. In fact, the sinuses usually exist for a long time.

It may be said that, whereas nephrotomy is not as dangerous to life at the time as nephrectomy, it is not as good a procedure for a final recovery.

Nephrostomy is the operation of nephrotomy plus suturing the sides of the kidney to the loin incision. This has its advantages and disadvantages in tuberculosis. The advantage is that the opening in the kidney is directly beneath the incision and therefore the treatment of the diseased organ locally is more easily performed than when the kidney is allowed to return into its fossa, which is partially beneath the ribs. The disadvantage of nephrostomy is that, after the organ has been fastened to the abdominal wall, there may be a leakage of urine and pus into the perirenal tissues between the edges of the kidney and those of the incision that cannot be estimated without cutting the sutures or tearing away the kidney from its new position. It is easy to fix the kidney successfully in a clean case, but more difficult when considerable pus is present. In the majority of cases in which the kidney is opened and drained, a secondary nephrectomy is necessary. It very often happens, however, that a patient who will not permit of an immediate removal of the organ, will first consent to a nephrotomy, which will give temporary relief, and later to a nephrectomy. With this end in view, it may be said, therefore, that it is better to perform a nephrostomy than a nephrotomy, for then in the case of a secondary nephrectomy, we will have better command of our kidney, which has previously been brought into the operative field.

Partial nephrectomy may be employed when but one pole of the kidney is diseased. This is not a practical operation, as it is extremely difficult to judge of the degree of the involvement by simply cutting down on an organ which is infiltrated with tuberculosis, or even by making an incision through such an organ, as the hemorrhage is always excessive and inspection of the interior of the kidney is difficult. Again partial nephrectomy is, to my mind, a very serious operation on account of the amount of blood the patient loses. It is necessary in such cases to cut through a portion of the pole of the organ very close to the pedicle and at a point at which the blood vessels are large and very difficult to control. Besides this, a considerable amount of pressure is exerted on the healthy tissues by the sutures in drawing the wound together and this might cut the renal tissue instead of holding it.

Nephrectomy is, then, the only radical operation for the cure of renal tuberculosis, provided the disease is unilateral. There are certain points to be considered in the operation, namely, the position of the patient, the incision, the treatment of hemorrhage that may occur, the handling of the ureter, the disposition of the fatty capsule, the closing of the wound, the question of drainage, besides the immediate dangers resulting, such as shock, hemorrhage, sepsis, peritonitis, as well as the more remote one of a fistula.

The position of the patient depends upon the incision in nephrectomy as well as in nephrotomy. The incision should be free, which would require the patient to be either on his back or on his healthy side. Probably ninety-five per cent of the patients operated on are placed on the healthy side and the incision made is either curved or oblique, usually the former. In either case, the incision in the muscular wall begins at the outer side of the erector spinæ muscle, just below the twelfth rib. If curved, it is continued downward and outward along this muscle until it approaches the crest of the ileum, when it is curved toward the anterior superior iliac spine; in the case of the oblique incision, it is parallel to the twelfth rib throughout its entire extent. The curved incision is the one that I am in the habit of using and is the more popular method. Sometimes, on cutting through the abdominal wall, pus is found, showing that a tuberculous abscess has discharged through the external capsule. In fourteen per cent of the cases that I operated, there was pus outside of the kidney, perinephritic abscesses, in nearly all of which the opening of the abscess in the kidney could be detected.

In some of my nephrectomy cases, there were very dense, adherent and thick infiltrations into the leaflet of the perirenal fascia, so that it had to be clamped and ligated in several places before the pedicle could be reached. There is a great difference in the amount of bleeding in patients, but if ligatures are placed, by means of the needle, before removing the clamp and before cutting through the dense tissues above and below the kidney, it would be much lessened. The adhesions with surrounding tissues can often be broken up more easily and

the hemorrhage lessened by occasionally pouring in peroxid of hydrogen. In case the capsula propria of the kidney and the fatty capsule are fused together to such a degree that they cannot be separated, it is well to do a subcapsular nephrectomy, peeling off both capsules together from the kidney parenchyma. (See Subcapsular Nephrectomy.) Having brought the organ well down, the appearance of the kidney and ureter should be noted. Nodules on the kidney or abnormally soft areas indicate tuberculosis or stone, with pus cavities. Thickening of the ureter is always a sign of tuberculosis of the kidney, as are clusters of tubercles under the capsula propria.

Aspiration of the Kidney.—If the organ is found to be full of pus after it has been made freely accessible, it may be manipulated more easily by aspirating the pus cavity and allowing the pus to flow out through a tube over the side of the patient into a pus basin.

Treatment of the Ureter.—When the kidney is brought out of its abdominal cavity, hanging by its ureter, the question arises as to the best method of severing it from its attachment. The kidney is usually the original seat of tuberculosis of the urinary tract, the infection traveling down the ureter to the bladder in many cases, and consequently it is important to remove as much of the duct as is diseased. I have been in the habit of placing two ligatures a short distance below the pelvis, cutting between the two and thus separating the kidney, cauterizing with pure carbolic acid the end of the divided ureter that is to remain, then treating it with alcohol and either returning it to the abdominal cavity or else attaching it to the incision. The latter procedure is, I believe, preferable, as, in case the ureter does not drain well into the bladder, and there is retention of pus in it, the wound can be reopened and it will be more easily found. Many advocate removing as much as possible of the ureter. Some are still more radical and say that the duct should be removed down to the bladder, or even together with a piece of the bladder wall. In removing large portions of the ureter, it is necessary to make correspondingly large incisions, or else to make another incision independent of the one in the loin, farther down in the groin, or just above the pubes on one side or the other. This is especially true in males; whereas, in the female, the incision can be made on the inside of the dome of the vagina to one side of the cervix and the ureter caught with a hook through this incision just as it enters the bladder. It can be pulled down into the vaginal cavity, ligated, cut through (Kelly method) and removed in its entirety by this route or else by pulling it through the kidney incision.

Personally, I have never fished the ureter down through the vagina, but I have been told by my colleagues who have performed this operation, that it is comparatively easy. I have at times felt tuberculous ureters through the vagina, as they are often very much thickened. In any case, before resorting to such a procedure, it would be well to introduce a ureteral catheter, as this imparts a firmer feel to the canal and consequently aids in detecting it. Until I begin

to have more serious trouble with the ureters after removing the kidney, I shall continue to ligate and cut through them just above the lower end of my incision in the loin and fasten the end to the lumbar fascia, in which case they usually atrophy and give rise to no further trouble.

In nephrectomy, the great danger to life must be considered and it is better to do an incomplete operation quickly when the patient's condition is not good, than a more radical one that may result in death. I had one unfortunate experience that led me to consider the importance of subcapsular nephrectomy. I had loosened the kidney from the combined internal and external capsules, which were adherent to one another, and I could have done a subcapsular nephrectomy in a few minutes. I thought, however, that it would be wiser to remove the kidney with its capsule, which was also involved, than to leave the united capsules. Numerous difficulties were encountered from the bleeding points and it required time to check the hemorrhage. The bleeding from the pedicle also required clamps and packing. The patient lost a considerable amount of blood and died from shock in a few hours, whereas his life would probably have been saved had I performed a subcapsular operation. Fig. 317 shows the kidney as it appeared some time after removal. The operation was a secondary nephrectomy following a former nephrotomy.

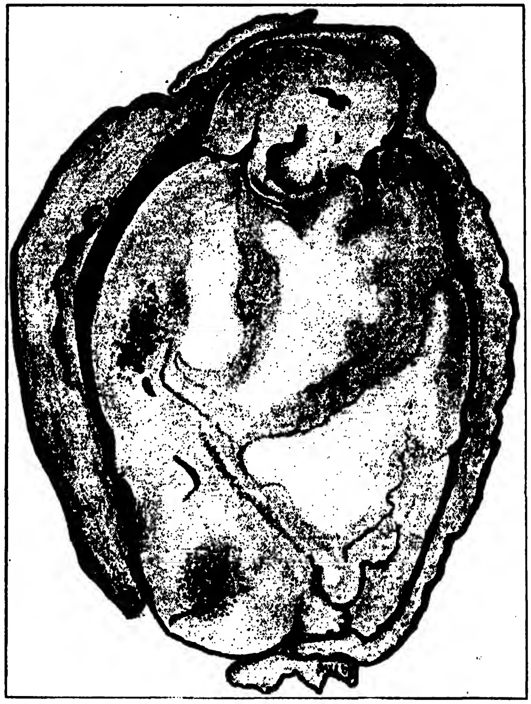


Fig. 317.—A Vertical Section of a Tuberculous Kidney Removed by a Secondary Nephrectomy with a Fatal Result. Note the fused capsules and the mass of thickening of the renal tissue. There is no sign of normal kidney tissue and the organ was much thickened. (Author's case.)

Treatment of the Fatty Capsule.—This is another important consideration in operating on tuberculous kidneys. In separating the fatty capsule from the capsula propria, we often see superficial clusters of tubercles, which are breaking down and undergoing a suppurative process, that are adherent to the fatty capsule. Sometimes the covering of these clusters is torn away with the fatty capsule, in which case there is a tuberculous process left in the adipose tissue, and a septic process if pus-producing germs are present. The fatty capsule is involved in a number of cases, and if the kidney is removed the tuberculous process may continue in this tissue. It is therefore advisable in all of

these cases to remove as much of the fatty capsule as we can and then to wash out the cavity with peroxid of hydrogen.

Closing of the wound after a nephrectomy for tuberculosis is another important consideration. I see no reason why it should not be closed if no pus has been found in the urine coming from that side on ureteral catheterization nor during the operation. Again, if there is pus present in the urine or wound, and the ureter has been doubly ligated, cut through between the ligatures and its ends cauterized, I see no reason why the wound should not be closed after washing out the renal fossa with a solution of bichlorid of mercury or with peroxid of hydrogen. In case, however, that there are adhesions between the surrounding tissues and the suppurative areas on the surface of the organ, or a kidney abscess breaks during the manipulations required for its removal, or if in any way pus enters the renal fossa, it is advisable to put a drain down to the site of the kidney. If drainage is inserted as a precaution when we consider that we have cleaned our field thoroughly, it should be removed at the end of twenty-four or forty-eight hours; for if it is left for two or three days, it tends to induce suppuration.

In cases in which the wound is packed with gauze after the operation, the removal of it sometimes causes an elevation of the temperature.

Treatment of Perinephritic Abscess.—In case of tuberculosis of the kidney being associated with perinephritic abscess, we should be satisfied with evacuating the abscess, examining the pus cavity and draining it at the first operation. When the relations of the kidney have been reëstablished, further operative procedures can be carried out later on. This was contrary to my belief some time ago, when I thought it advisable to do as much as possible at the first operation.

After-treatment of Nephrectomy.—In the event of a profuse hemorrhage at the time of the operation, we should give one thirtieth of a grain of strychnin hypodermically and, in case the pulse is rapid and weak, saline intravenous should also be given. If there has not been much hemorrhage, but sufficient to lead us to think that shock may follow, it is well, in addition to the hypodermic of strychnin, to administer a pint of hot saline with two ounces of whisky by enema as soon as the patient is put to bed. After this, a pint of hot saline without the whisky and one thirtieth of a grain of strychnin can be continued every four hours, alternating so that the patient will have one or the other every hour until the pulse is satisfactory and the danger of shock has passed.

Temperature after Operation.—After operation, my patients ran a temperature of from 100° to 101° F., and the pulse ranged from 90 to 100 in favorable cases, becoming normal in from three to seven days. In other patients, the temperature ran from 101° to 105° plus F., and the pulse from 120 to 140. The cases with high pulse and high temperature usually did badly.

The patient's bowels are usually moved on the second day after operation

by magnesium sulphate followed by a soapsuds enema. If the bowels do not move on the following day, compound cathartic pills are given.

The amount of urine passed the first day after operation averaged one pint, and from forty ounces upward after this.

Salt solution was given to patients developing uremia, by enteroclysis or hypodermoclysis, and some were bled, this being followed by a saline infusion. Uremia occurring immediately after operation is of very bad augury.

Complications.—Peritonitis is a very rare complication, but may occur if the peritoneum has been torn through at the time of the operation. I have had this accident, but it was never accompanied by peritonitis. I simply washed with salt solution and closed the tear with catgut.

Sepsis, depending upon infection of the renal fossa, requires prompt and thorough measures for its removal. If the wound has already closed, it must be reopened and the pus pockets must be carefully sought for and drained.

Sinuses frequently occur in septic cases and are very difficult to cure. Those due to a silk ligature will close when the ligature is removed. A sinus caused by infection persists for a long time. The walls of sinuses in these cases are often covered with tubercles, which are treated by curetting; swabbing with carbolic acid and alcohol; packing with iodoform or balsam-of-Peru gauze. At times they are very obstinate, and the wound may not close for weeks. The chromic-gut sutures in the muscular wall and skin sometimes give way and there is a wide gap in the loin into which several fingers can be introduced. In such cases, there are usually tuberculous deposits along the sides of the wound. The presence of a sinus tends to keep the patient below par through a certain amount of pus absorption. The longest period that a tuberculous sinus existed among my cases was for nine years following a nephrotomy, when it gradually healed. After one nephrectomy there was a gaping wound, with a tuberculous process on its sides for six months. It was dressed with iodoform and balsam-of-Peru gauze, irrigated with silver and bichlorid and even swabbed with carbolic and alcohol, with no effect. The wound was kept strapped and eventually healed. I believe that, in certain cases after a nephrotomy or the opening of a perinephritic abscess, the tuberculous process may continue in the organ until it has become completely destroyed, when the sinus will close.

Results.—Among my patients, death in the first few days after nephrectomy was due either to shock, asthenia, anuria, or uremia, in ten per cent of my cases. In some of the fatal cases, it has been interesting to learn from autopsy that the patient could not have recovered on account of the condition of the other kidney and yet the tests for the renal function appeared favorable, while the acute infectious process in the diseased kidney was so alarming that it seemed that the organ should be removed as an emergency operation. Such cases should, I think, have been treated by nephrotomy and drainage, and a secondary nephrectomy. On the other hand, there were certain cases in which

the renal function tests and the signs of tuberculosis elsewhere were so unfavorable, that I told the patients that I thought the result of a nephrectomy would be fatal, whereupon they went to other operators who, without testing the renal function, operated with a successful outcome.

In one case, the patient's only kidney was removed, but this was in the days before we employed ureteral catheterization in the hospital. I have gained much experience from my mistakes in early cases, and, although I was then doing what was considered right, I now see that my course was wrong and I have learned to realize the importance of studying each case carefully myself instead of relying on the opinions and examinations of others. The above-mentioned case has been a lesson to me never to remove a kidney until all my customary routine examinations have been made by myself and my associates. Many of my patients have gone to other surgeons on account of my insisting upon this, but my mortality statistics have been greatly improved by my refusal to operate them.

Nonfunctionating or Derelict Kidneys.—One kidney can sometimes be destroyed while the other carries on its function. In one case of unilateral renal tuberculosis, with involvement of the bladder, testes, prostate and seminal vesicles in a patient running but one degree of temperature and not losing weight, I am inclined to think that, if no operation had been performed, the kidney would have been destroyed entirely in a short time and the patient's condition would have remained practically unchanged. The kidney after removal was found to have four fifths of its tissue destroyed. I have seen other kidneys in which probably seven eighths had been destroyed, and the other kidney has been able to carry on the function, after the removal of its fellow. I have had three kidneys in which the entire parenchyma had been practically destroyed and which could excrete only a little pus or a small amount of watery fluid containing pus. One of these I removed at autopsy. The other two were extirpated in operation; one was a pyelo-nephritic kidney, and the outcome was death; the other was a pyonephrotic kidney and the patient made an uneventful recovery. There are many persons with one nonfunctionating kidney, a large percentage of which are destroyed by tuberculosis.

Medical Treatment.—There are a number of patients suffering from tuberculosis of the kidney who must be treated medically. First, cases in which the disease is suspected and yet the diagnosis has not been made; second, when both kidneys are too much involved to warrant the removal of one of them; third, in case of patients who need the operation but do not consent to it.

When we are studying suspected cases of renal tuberculosis and before the tubercle bacillus has been found, the patient should be treated symptomatically, and if we think that tuberculosis is present, the same treatment should be given as if the diagnosis had already been made. This is advisable for the reason that, in many cases, a number of urinary and cystoscopic examinations have to

be made and several days or weeks may pass before the diagnosis is completed and operative or other treatment decided upon.

My observations in the treatment of certain patients have convinced me that a number of cases can be cured by medical treatment. In connection with the general treatment of the renal condition, advantage should be taken of the opportunity to treat the bladder as well, in case it is involved. The treatment consists of rest, proper diet and clothing, fresh air and drugs. Among the last-mentioned we have the so-called specifics: Creosote, guaiacol and cod-liver oil. Among the tonics which are the most useful are: Sirup of iodid of iron, Basham's Mixture and strychnin. The urinary antiseptics that I use are: urotropin, salol and benzoate of soda.

Method of Life.—The method of life is of great importance. The patient should at all times be comfortable and free from worry. In case the bladder is involved, giving rise to great frequency of urination, pain and tenesmus, a rubber urinal should be worn during the day, strapped to the leg, and a glass urinal should be kept beside the patient in bed during the night. The ease and relief that is obtained in this way does much toward his improvement and peace of mind. As little time as possible should be devoted to business. The patient should rest at home in the evenings and on damp, unpleasant days, lying about on a couch or reclining in a comfortable chair. In these cases, as in those of tuberculosis of the lungs, fresh air and sunshine are of great importance; therefore, the patient should remain out of doors as much as possible when the sun is shining. Exposure to draughts of air should also be avoided. The body should be kept warm, special attention being given to the legs and feet. Woolen underclothing or flannels are the most suitable. When out walking about, great care must be taken not to perspire and then sit about in the sweat-soaked garments, but to return home and change the clothing.

The diet in tuberculosis of the kidney should be similar to that of tuberculosis of the lungs, excepting that forced feeding should be avoided. If the patient is very ill, a milk diet should be given; otherwise, cereals, eggs, fish, meat and green vegetables in moderate amounts. Anything tending to interfere with digestion should be avoided. In fact, we may say that the diet in tuberculosis of the kidney should be a mixture of that of the consumptive and that of the nephritic.

Drugs.—Creosote and guaiacol, the specifics in pulmonary tuberculosis, are, I believe, of as much or more benefit in tuberculosis of the kidney. I am in the habit of using creosote carbonate, three grains, three times a day. Guaiacol I have used but rarely and cod-liver oil never. Sirup of iodid of iron is, in my opinion, the next best remedy to creosote in such cases. I am in the habit of giving it mixed with equal parts of sirup of bitter orange peel, a half to one teaspoonful to the dose, between meals, in milk or water. Basham's Mixture (mistura ferri et ammonii acetatis), two drachms three times a day, is another good iron mixture.

Urotropin is, I presume, of great value as a urinary antiseptic, especially when there is a suppurative process in the tubules of the kidney and renal pelvis, as well as in the ureters and bladder. It tends to convert the urine into an antiseptic wash. Personally, I do not know the exact benefit to be derived from urotropin in such cases and think that it would require considerable study to be able to determine it. I only use it in cases of pyonephrosis with retention of pus. Benzoate of soda, in my practice, has been the urinary antiseptic best borne by the patient. The exact relative value of the two is unknown to me.

Bladder cases are relieved by antispasmodics, such as belladonna, codein, morphin and the bromids. The prescription that I usually give under these conditions consists of tincture of belladonna, 2 drachms, benzoate of soda, 4 drachms and aqua Gaultheria, up to 2 ounces; a teaspoonful three times a day, between meals. If this does not relieve the pain, I add codein so as to give $\frac{1}{4}$ of a grain to each dose. In many cases, this gives absolutely no relief, nor do any of the other remedies recommended for such conditions, and I have to give morphin and bromid of potash. The mixture I use in such cases is composed of morphin, $\frac{1}{6}$ to $\frac{1}{4}$ of a grain, and bromid, 15 grains, to the dose; while, in certain other cases that I have had, this has not been efficacious until I added 8 grains of chloral hydrate to the dose. At first I gave this mixture of morphin, chloral hydrate and bromid with some apprehension to patients with tuberculosis of the bladder, when the kidneys were involved. It gave the patient great relief, however, and the urine examination showed no ill effects of the medicine upon the kidney.

There is no need of going into details of the bladder treatment in the consideration of the trouble of which we are speaking. I will add, however, that boric-acid irrigations of the bladder have very little effect. Nitrate of silver irritates the bladder as does also bichlorid of mercury. In these cases, after bladder irrigations with a solution of nitrate of silver, by a very small rubber catheter and a fountain syringe, I have found that if an injection of argyrol into the bladder is made after the silver solution has been allowed to run out, the irritation following silver irrigations has been very much relieved. I have thus been able to use from a 1 : 2,000 to a 1 : 1,000 solution of nitrate of silver in the bladder, by injecting 2 or more drachms of a 10-per-cent to a 25-per-cent solution of argyrol after the bladder had been emptied of the silver solution.

In this way, I have absolutely cured tuberculous bladders with ulcerations. Gommenol is also a valuable remedy, to be injected ($\frac{1}{2}$ oz.) into the bladder in a strength of 10 per cent to 50 per cent and allowed to remain. Iodoform emulsion, 2 per cent in strength, is also of value.

Strictures of the urethra should be dilated or cut. This is of great importance, as is also the cutting of a narrow meatus.

Regarding the second group—the cases in which both kidneys are too much involved to warrant removal of one of them—and the third group, in which the

patients who need operation refuse to be operated, I would say that they are treated by the same restorative and supportive measures. These patients should be weighed carefully at frequent intervals, and the amount of pus voided should be estimated often, as these two measures serve as the best guides in judging the progress of the disease.

A change of climate and of surroundings is also valuable and the same climates that are of value in tuberculosis of the lungs are also of value in tuberculosis of the kidney; that is to say, a dry equable climate where the patients can remain out of doors. I do not think that the cold of the mountains, such as the Adirondacks, is of benefit, but rather the milder climates of Nassau, Bermuda, and southern California. I have a number of patients at present, who have refused to be operated for two or three years, and who are in the same condition as when they called for an opinion, at which time it was considered advisable to operate upon them.

Patients with pus coming from both kidneys, with the bladder involved as well, have also been absolutely cured by the treatment that I have outlined, and yet I consider it extremely dangerous to take chances with medical treatment and recommend nephrectomy in all cases in which one kidney is involved, if the other is absolutely normal.

Under conservative treatment, a few patients gained weight, but most of them lost, and this did much toward leading them to operation. Some patients, however, waited too long, until the period when they could be successfully operated on had passed.

Illustrative Cases.—Regarding the successful treatment of renal tuberculosis without operation, I will report two cases which come to my mind, whose symptoms closely resembled each other, as did the course of the disease.

CASE No. 1.—The first patient, a well-built real-estate man of healthy appearance, forty-six years old, with no venereal history. He began to have increased frequency of urination five months before his visit to me, at which time he was urinating with pain and tenesmus every fifteen or twenty minutes, both day and night, so that his sleep was disturbed and his general condition very much weakened.

Examination.—There was slight tenderness in his loin, more marked on the left side. His testes and epididymis were normal, his meatus measured 19 French. The prostate was nodular; the vesicles were negative. The urine was opaque, of a milky or starchy color, low specific gravity; albumin, one quarter of one per cent; pus, many cells and in masses; a few red blood cells; casts, hyaline, granular and pus; epithelia from renal tubules and pelvis, ureter, bladder and prostate. The diagnosis from the urinary examination at the time was interstitial nephritis, pyelo-nephritis and slight cystitis.

The treatment for the frequency and tenesmus was a mixture of benzoate of soda and belladonna; hot sitz baths twice daily. The bladder was treated

by irrigations with a silver solution, 1:8,000 to 1:2,000, by catheter, and the prostate massaged every other day. These measures failed to relieve the patient, who continued to suffer, especially at night.

The following treatment was adopted with favorable results: For the pain and tenesmus and frequent urination, morphin $\frac{1}{6}$ of a grain, chloral hydrate $7\frac{1}{2}$ grains, bromid of potash 15 grains, in a mixture every four to six hours. Urotropin 10 grains, three times daily. Creosote was also given internally, as the disease appeared to me to be reno-vesical tuberculosis. The bladder was washed once daily with nitrate-of-silver solution, followed by half an ounce of a twenty-five-per-cent solution of argyrol. A rubber urinal was worn during the day and the patient was instructed to sleep with a glass urinal between his legs at night.

The meatus was cut to 32 French. Sleep promptly improved and the patient's physical and mental condition were appreciably relieved.

He was cystoscoped under ether and his bladder capacity proved one ounce and a half. It required three quarters of an hour to obtain a sufficiently clear medium to look through, on account of the pus coming down from the kidneys. The prostatic base was red, resembling a strawberry, the redness extending along the trigone. There was a small ulcer near the mouth of the left ureter and many flocculi were seen coming from it. There was also a typical tuberculous ulcer on the anterior wall of the bladder near the sphincter. Two small bodies resembling small calculi were seen lying behind the trigone; but these were no longer visible at the time of a later cystoscopy. The bladder was but slightly inflamed. The clinical picture was one of tuberculosis of the kidney with extension to the bladder; but no tubercle bacilli could be found in the urine, although it showed the colon bacillus, the staphylococcus and the streptococcus. Operative interference seemed to be indicated, but meanwhile the patient's condition was improved. The ureters were catheterized and an impediment was encountered in the upper part of the left ureter. After the catheter had been pushed into the renal pelvis, two drachms of urine escaped, of a starchy color and a low specific gravity and containing a large amount of pus and mucus, showing pyonephrosis on that side. The right ureter was not strictured and there was no renal retention on that side. The condition was pyelonephritis.

The patient had a marked polyuria; there was pyonephrosis of the left kidney, due, I believe, to a partial destruction of that organ by a mixed infection with tubercle bacilli and pus-producing germs. The obstruction of the left ureter could be accounted for by a tuberculous thickening or stricture and the ulcer near the mouth of the left ureter I believed to be the result of the descending process through the duct. The ulcer on the vesical wall was typically tuberculous, and the bladder was slightly inflamed.

The condition in the kidney was a much more extensive process than that in the bladder. Tubercle bacilli were found in the urine a few days afterwards,

corroborating the diagnosis of urinary tuberculosis. The patient was kept under the treatment already outlined for about one month and was relieved of his pain; then he was sent home to continue his medical and hygienic cure. His condition steadily improved and one year later he reported freedom from symptoms and absolutely normal urine, excepting a slight deficiency in urea. The patient has been seen repeatedly since and has continued in perfect health for five years.

CASE No. 2.—The second patient, whose history was much shorter and more involved, was an expressman, twenty-one years old, about 5 feet 8 inches, pale, thin and gaunt, having recently lost thirty pounds in weight. Five months before, the patient had urethritis and three weeks before frequent urination set in, until urine was passed every fifteen to twenty minutes, both day and night, with burning and tenesmus. The second urine was white, turbid, of a starchy or milky hue; at other times it resembled rainwater. His prostate was soft, with the exception of a nodule on the left side; vesicles tender. The bladder held but a few drachms. He was put upon the same treatment as the first patient and his meatus, which had been 17 French, was cut to No. 32 French.

The urine showed a specific gravity less than 1.001, slightly acid; albumin 15 per cent by bulk (Heller's test); urea $\frac{7}{10}$ of 1 per cent; an occasional red blood cell; pus, innumerable cells, small masses and pieces of pus casts; casts, hyaline, granular and pus; epithelia, granular, renal and vesical; bacteria, gonococci, colon bacilli and tubercle bacilli. The general specimens showed a reno-vesical tuberculosis. The kidneys were markedly involved pyelo-nephritis. The patient, under the treatment already outlined in Case No. 1, was improving slowly and gaining in strength and weight. Cystoscopy was tried, but he could not tolerate sufficient fluid in his bladder. Finally it was performed under a general anesthetic. The bladder held at this time three ounces; it was much congested about the trigone and somewhat inflamed. Small ulcerations were seen about the mouths of the ureters. Catheterization of the ureters was performed, the catheters remaining in for one hour.

The examination of the two specimens was as follows:

Right	*Left*
Quantity—27 c.c. (ʒvij).	Quantity—93 c.c. (ʒiij).
Sediment—slight.	Sediment—none.
Colorless.	Colorless.
Albumin—10 per cent by bulk.	Albumin—25 per cent by bulk.
Sugar—negative.	Sugar—negative.
Urea—$\frac{4}{5}$ of 1 per cent.	Urea—$\frac{1}{3}$ of 1 per cent.
Indican—negative.	Indican—negative.
Red blood cells.	Red blood cells.
Pus cells and pus in masses.	Pus cells and pus in masses.
	Casts, hyaline, granular and pus.

The process had been principally in the left kidney, and the pus, mixed casts and pus casts formed had principally come from this side.

The patient gained eleven pounds during the first month and twenty during the second. One year afterwards he weighed 180 pounds. The symptoms in his case were more acute than in Case No. 1. The polyuria was more marked; the specific gravity and the urea were less. The process was much more marked in the kidney than in the bladder. There were ulcers about the mouths of both ureters, showing a descending infection. The patient ran but a slight temperature, however, never more than 100° F., which was a little more than Case No. 1. He was under treatment for two months and, when he was obliged to return to his home at this time, his condition was much improved. He could hold his urine an hour or more during the day and only urinated four or five times during the night. His urine was also beginning to assume a normal color. The patient has reported to me since then and his urine has become practically normal, with the exception of a few pus cells and a slightly diminished amount of urea.

The favorable outcome of these cases, without surgical interference, does not in any way alter my opinion, as expressed above, that renal tuberculosis calls for timely nephrectomy in the best interests of the patient, as soon as a positive diagnosis has been made and the functional sufficiency of the opposite kidney has been established. The following conclusions will, therefore, show that I consider tuberculosis of the kidney a disease to be treated surgically in the majority of cases.

Conclusions.—(1) I believe that there are many cases of polyuria of tuberculous origin not diagnosticated as such.

(2) I believe that there are many cases of tuberculosis of both kidneys in which the process is cured under improved general conditions of treatment and hygiene, and consequently increased bodily resistance.

(3) I believe that there are patients with double tuberculosis of the kidneys, one organ more involved than the other, in fairly good health and running a slow course, who, if allowed to go on conservatively, under supportive treatment, would survive the disease, through the healthier kidney performing the work for both, while the one more affected would continue to degenerate until entirely destroyed.

(4) I believe that, in any suspected case, we should immediately make animal inoculations and examine specimens of urine frequently.

(5) I believe that most cases of tuberculous kidney are not operated on early enough.

(6) I think that better coöperation should exist between the patient and his physician, on the one hand, and the surgeon on the other.

I may here add that, since writing this chapter, I have had other cases in which reno-vesical tuberculosis has been found, that have been successfully

treated by the treatment above outlined. One case, a man who came to me two years ago with renal tuberculosis on one side and a healthy kidney on the other, was sent to the hospital for nephrectomy. He delayed entering for three weeks. Then he was again examined when about to be operated upon while under ether and found to have an acute parenchymatous nephritis of the former healthy kidney. He was accordingly returned to bed and not operated. Since then I have kept him under observation and for the last year he has been symptomatically well and heavier than ever before.

Statistics of nephrectomy in renal tuberculosis, by Albarran, of some of the prominent operators up to 1905 shows:

Albarran—64 cases, 2 deaths.
Rovsing—47 cases, 3 deaths.
Kümmel—43 cases, 5 deaths.
Israel—41 cases, 4 deaths.
Krönlein—34 cases, 2 deaths.
Casper—20 cases, 2 deaths.

The total is 7 per cent mortality.

CHAPTER XXX

HYDRONEPHROSIS

(*Uronephrosis*)

Hydronephrosis or uronephrosis is a chronic distention of the pelvic cavity by an aseptic liquid derived from normal urine, with progressive sclerosis of the walls of the sac.

It is clinically not a common disease and the apparent frequency is not so great as the real frequency, for there are many latent cases discovered only at autopsy. It is twice as frequent in females as in males and usually affects the right side.

Etiology.—*Obstruction of the excretory channels* of the urine and, more particularly, incomplete obstruction of the ureter constitute the etiology of hydronephrosis. Obstacles in the lower urinary tract due to congenital anomalies of the urethra, such as a narrow meatus, valvules or strictures may serve to dilate the kidney, but only after the whole urinary tract has been distended to a variable extent. The moderate bilateral distention seen sometimes in old neglected cases of acquired strictures of the urethra is rarely aseptic and, even if it is, it does not deserve to be considered as a disease in itself, being only the last stage of a generalized urinary dilatation. Complete and sudden obstruction of the ureter by stone or experimental ligation is not a cause of true hydronephrosis, as in these cases the kidney at first becomes somewhat dilated; but this stage is short, and is rapidly followed by renal atrophy and sclerosis.

Incomplete obstruction of the ureter is then the true cause of hydronephrosis, either congenital or acquired. The group to which a given case belongs is usually evident, and yet it is sometimes difficult to decide what was the primary cause. The tendency at present is to recognize as congenital many cases that were formerly classified in the acquired class.

Congenital Hydronephrosis.—The knowledge of a few embryological conditions enables us to understand why and how it develops. The ureter, during intra-uterine life, is not the smooth canal we are accustomed to see in the adult, but is constricted in some places and dilated in others, besides showing in its lumen numerous *valvules* formed either by the mucosa alone or by both the mucous and muscular layers. These formations are met with most frequently at the uretero-pelvic junction and next at the lower end of the ureter. These *normal* valvules disappear later under the influence of a normal growth

and of the pressure of urine. In most cases, however, they have not completely disappeared at the time of birth and consequently the ureter in the newborn still shows a number of irregularities, both on its outer and inner aspects, that must be considered *congenital defects* and later may cause a partial obstruction of the ureter.

If the obstruction is very marked, hydronephrosis develops during fetal life and exists at the time of birth, sometimes of a very large size; but oftener the obstruction is but slight and then the retention is more progressive, requiring years of slow advance to develop into a clinically appreciable tumor. This explains why hydronephrosis appears especially as a disease of the third decade of life. Besides the increase in size of the renal pelvis (the sac), hydronephrosis is attended by the development of certain secondary lesions, such as valvules at the pelvic origin of the ureter, kinks, bends and adhesions of the upper ureteral segment. All of these complete and tighten the obstruction and to the superficial observer seem to be the real cause of the retention, as they are much more apparent to naked-eye examination, and much easier to detect, than the often small and indistinct congenital defect which has been the real cause of the trouble. For this reason, the importance of congenital causes has not been properly estimated, until of late when a careful study of the subject has shown the true cause. Valvules are the most frequent congenital defects, but *congenital, ureteral strictures* also occur and exert the same causal influence.

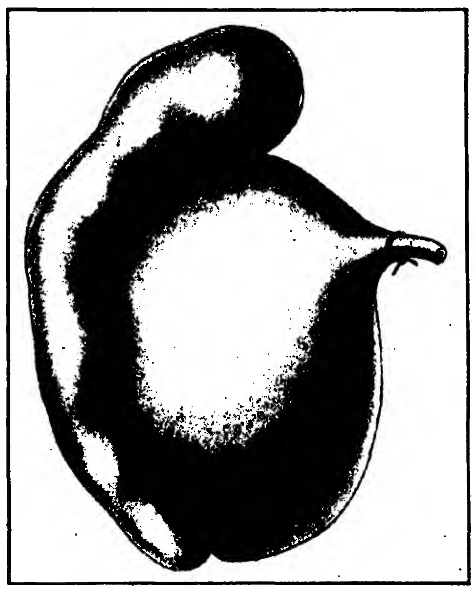


Fig. 318.—Hydronephrosis in a Kidney 7 Inches Long, Situated at the Sacro-iliac Synchondrosis. (Author's case.)

An anomaly of position also predisposes to hydronephrosis. Fig. 318 shows one of my cases which was located at the sacro-iliac synchondrosis. An effort to replace it failed and it was removed. The body of the kidney was seven inches and very thin. The pelvis was of large size.

Besides the lesions of the ureteral wall itself, some outside anomalies may also reduce the caliber of the duct and cause uronephrosis. Such compression may be due to an abnormal blood vessel, generally an artery, very exceptionally a vein. It was found in three out of four cases (seventy-five per cent) that the inferior branch of a renal artery, given off prematurely, passed in front of the uretero-pelvic junction, whereas in the remaining case it passed pos-

teriorly. Some writers contend that an artery passing anteriorly cannot cause hydronephrosis, and it is certain that in most cases this is true, but when the dilatation begins exactly at the point where the artery crosses the duct, it may have a causative action.

The ureter was also found in one case to be compressed by a band representing the remains of the duct of Müller, and in another case by a band representing traces of the Wolffian duct.

A faulty position of the ureter may also result in a narrowing of its lumen. *Kinks* have often been accused, but it seems that in many of the cases the kinking was secondary to the hydronephrosis and not its cause. The same may be said of a faulty insertion of the ureter, that is, either too high or too obliquely into the pelvis.

Torsion of the ureter is always mentioned among the causes of congenital hydronephrosis, and yet, real torsion is exceedingly uncommon, as there are only four authentic cases of such a condition on record.

In *exstrophy of the bladder,* the fundus of the viscus forms an inverted pouch in which the intestines lie, and the loops of gut press on the ureter. Sometimes the ending of the ureter in the bladder is not normal, either because the ureter, after having gone too far down in the true pelvis, must take an ascending direction to reach the trigone, or because the intraparietal course is too long and too oblique.

Next to the anomalies in the position and caliber of the ureter, the anomalies in number of the ducts are generally mentioned as possible causes of this trouble.

This is not a probable cause, however, as the *absence of one ureter* cannot be a cause of hydronephrosis, for the simple reason that, if the ureter does not develop, the pelvis cannot exist. Neither can *supernumerary ureters* cause a retention unless they are strictured, in which case the stricture and not the numbers of ureters is the cause. The same applies to abnormal endings, for here also a strictured condition of the end must exist to cause retention in the kidney on that side. When a supernumerary and strictured ureter causes a hydronephrosis, it almost invariably corresponds to the upper half of the kidney.

Congenital hydronephrosis is often associated with abnormalities of the kidney. It has been seen in single kidneys and it is not very rare in horseshoe kidneys, on account of the curve the ureter has to describe in order to pass in front of the isthmus.

Acquired Hydronephrosis.—We find here the same mechanism of obstruction: (1) By lesions of the walls of the ureter itself; (2) by a faulty position; (3) by external compression; (4) by occlusion by a foreign body lodged within the lumen.

(1) *Obstructive lesions* of the wall of the ureter are not very common. They sometimes result from tuberculous ureteritis. Ordinary ureteritis leads generally to pyonephrosis. Acquired strictures of the ureter are also rare.

(2) *Faulty positions* of the upper part of the ureter are produced chiefly by *kidney mobility.* The latter is not as predominant a cause of hydronephrosis as was formerly assumed. It seems fairly well established that many of the cases formerly attributed to it are really congenital hydronephroses due to some of those defects we have mentioned; but nevertheless, movable kidney is still a cause of retention. A change in the direction of the kidney and ureter, as in scoliosis, is sometimes sufficient.

The lower extremity of the ureter may be occluded in procidentia uteri, or when there exists an intravesical prolapse of that end.

(3) *External compressions* are the most important causes of acquired hydronephrosis and cancer of the uterus and of the prostate occupy the foremost place. Vesical tumors, uterine fibroids, tuberculous glands are other causes. Special mention must be made of pregnancy.

(4) *Obstruction by foreign bodies* includes stones and blood clots. The latter do not seem resistant enough to be the real cause of retrodistention, although, at one time, the theory of traumatic hydronephrosis was based upon them. Stones cause calculous hydronephrosis not so much by the obstruction due to the calculus itself, as by that due to the lesions of the ureteral wall caused by the pressure of the stone.

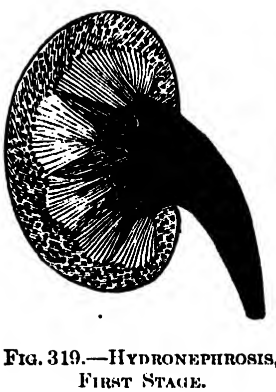


FIG. 319.—HYDRONEPHROSIS, FIRST STAGE.

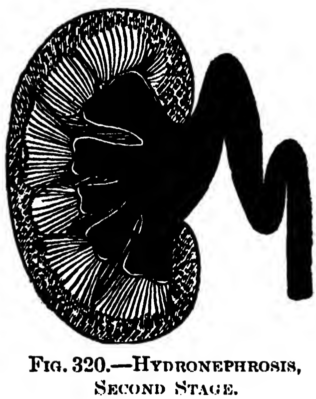


FIG. 320.—HYDRONEPHROSIS, SECOND STAGE.

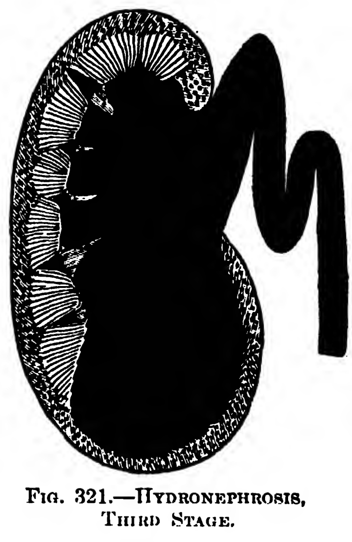


FIG. 321.—HYDRONEPHROSIS, THIRD STAGE.

Pathology.—When an obstruction occurs, the urine accumulates in the renal pelvis and calices as fast as it is secreted (Fig. 319). Gradually, the renal pelvis dilates and the urine, continuing to be secreted, compresses the renal substance, disturbing both the nutrition and the secreting capacity of the parenchyma and rendering the stroma anemic (Fig. 320). Gradually under the influence of the compression and degeneration of the renal vessels, which are pressed upon by the sac pushing forward as it distends, the kidney structures undergo the changes of interstitial nephritis. The stroma hypertrophies, the parenchyma degenerates and atrophies. The compression and distention continuing to the last, the kidney is converted into a large fibrous cyst, with a series

of pouches representing the calices, separated by thin septa, representing the remains of the columns of Bertini (Fig. 321). These pouches may communicate freely with the general cavity or be shut off from each other and from the pelvis by fibrous partitions. The relative degrees of the involvement of the pelvic calices and kidney structures varies in each case, the extreme type alluded to above being comparatively rare.

The *walls* of the hydronephrotic cyst may be thin, translucent, or thick and fibrous, even partially calcified in old cases.

Adhesions between the sac and the surrounding structures add sometimes considerably to the thickness of the walls. The size varies from a slight dilatation of the normal pelvis to an enormous bag occupying the greater portion of the abdomen, and sometimes extending to the true pelvis. This depends upon the permanency and the tightness of the obstruction.

The *contents* of the sac are at first simply urine, but changes promptly follow. In many instances, the fluid is of a very low specific gravity, and contains hardly a trace of urinary constituents, especially when the renal destruction is considerably advanced. The urinary salts are gradually absorbed by the blood from the hydronephrotic sac, so that but few remain. The contents may become ammoniacal, turbid, sanguinolent. If infection takes place, we have to deal with uropyonephrosis. Sometimes the fluid is thickened to a colloid mass and cholesterin crystals have been occasionally met with. Smaller or larger amounts of albumin, hyaline casts and epithelia have also been found in the sac contents.

The opposite kidney usually presents a low-grade nephritis, but much less marked than in case of pyonephrosis.

Symptoms.—Many cases remain latent. As a rule, the subjective symptoms are reduced to a minimum, and nothing calls attention to the condition until a bulging is noticed in the ileo-costal region on one side, when palpation will show a tumor varying in size within extremely wide limits. This tumor is usually first felt in the loin, but is sometimes distinctly abdominal from the beginning. In the majority of the cases, the tumor is not tender and appears as a rounded or lobulated swelling of an elastic nature, which can usually be ballotted when not too large and heavy or too flaccid. Fluctuation may be present when the walls of the sac are not too much thickened or when the tumor is not very tense. Respiratory mobility of the tumor, always more marked on the right side, may be elicited if the tumor is not too large.

Cystoscopy will show that one of the ureters is blocked and does not allow the passage of urine (complete obstruction), or that the jets are weak and delayed and do not recur in the same rhythmic succession as on the healthy side (incomplete obstruction).

Ureteral catheterization will show the presence and the situation of the obstacle, and in incomplete obstruction the catheter may be able to pass the nar-

row point and obtain a varying amount of urine from the renal pelvis. A comparison of the analytic features of the two urines, including the amount of chlorids, the freezing point and the amount of urea in the urine on each side, will show the difference between the urine of the healthy kidney and the hydronephrotic fluid, and give an idea as to the secretory value of the distended kidney.

The tumor may give rise, like any other abdominal tumor, to certain *pressure symptoms.* These are chiefly the result of the compression of the lungs and heart caused by the tumor pushing upward against the diaphragm, and of the compression of the colon due to the forward and downward extension of the enlargement. Digestive disturbances, especially obstinate constipation, are common symptoms of hydronephrosis when the sacs are of considerable size.

Symptoms referable to the cause of the obstruction, that is, renal calculus, uterine cancer and other conditions, may form the salient feature of the clinical picture, the hydronephrosis being altogether secondary.

In some cases, particular symptoms become so prominent as to justify the description of special types of the disease, such as the hematuric type, the painful type and the intermittent type.

Hematuria is not a regular symptom; in fact, it is very rare, but has been observed by several surgeons, and is sometimes very profuse. The contents of the renal pelvis may be sanguinolent or decidedly bloody. The urine may be lightly or deeply tinged with red. All this depends upon the congestion following distention.

Pain is not a prominent symptom in ordinary cases of hydronephrosis, but severe attacks of abdominal pain and renal colic are the rule in the type called intermittent. They sometimes occur when there are large and tense retentions and may even be seen with small sacs. The pain is chiefly due to the *distention of the pelvis.* It can be produced artificially by the injection of cold or hot water into the pelvis through a ureteral catheter. When a certain amount is reached, the pain becomes very severe, much like that of renal colic, and, if the distention is not promptly relieved, becomes unbearable. The mechanism of pain in hydronephrosis is thus made obvious.

Intermittence, in regard to the pain as well as the emptying of the sac, is a striking feature in many cases of renal retention, and a special type known as *intermittent hydronephrosis* has been based upon the connection which at first sight seems to exist between the evacuation of the sac and the arrest of the pain.

Clinically, intermittent hydronephrosis is characterized by periodical attacks of pain, during which the kidney becomes enlarged and the amount of urine voided falls off. Later, the pain subsides and the kidney decreases in size, while the amount of urine voided increases to, and sometimes considerably above, normal.

The mechanical cause of the distention and pain is the alternate tightening

and releasing of the ureteral obstruction, generally caused by a kink of the upper part of the ureter, in consequence of a movable kidney. When the kidney falls, the ureter kinks and urine is retained, hence pain from distention, swelling and oliguria; but when the kidney returns to its place, the urine flows freely, hence polyuria and reduction in the size of the hydronephrotic organ (page 405).

Unfortunately for the value of the theory, the succession of phenomena is not always as regular as it should be, as the amount of urine voided at the end of the attack is in excess of the normal amount and often out of proportion with the size of the organ. Sometimes there is more than a gallon after the attack in a case with a very small tumor; whereas in the same case catheterization during the attack did not show more than one ounce in the pelvis. Accordingly, there seems to be no real relationship between the amount of urine retained in the kidney during the period of oliguria and the subsequent polyuria.

A conclusion much more in conformity with truth would be reached in many cases if the swelling of the kidney were attributed to renal congestion instead of urinary retention, and the polyuria interpreted as the simple result of the preceding congestion.

While the feature of intermittence is especially pronounced in retention due to movable kidney, it is common to all renal retentions and is shown by each at some period of its development, generally during the early stages.

Complications.—Rupture of a hydronephrotic sac is rare. It may be intra- or retro-peritoneal. Complete and lasting anuria is also rare, but oliguria and intermittent anuria are common. In bilateral cases, uremia may supervene.

Infection is a much more frequent contingency. It leads first to uropyonephrosis, and ultimately to pyonephrosis.

Course.—The course of hydronephrosis is usually chronic and covers years. The tumor acquires a large size, the kidney tissue gradually undergoing complete destruction. Less frequently, the course is acute, with a number of painful attacks which recur at irregular intervals. A chronic hydronephrosis may occasionally change to the acute form or develop acute symptoms temporarily.

Diagnosis.—The actual diagnosis is based on the presence of a tumor in the flank and the immediate discharge of a large amount of clear aseptic fluid on introducing a catheter into the renal pelvis, or, if the ureter cannot be catheterized, by an exploratory incision and puncture of the sac.

The *differentiation* of hydronephrosis from conditions simulating it is not always a simple matter.

Suppurative conditions in the kidney itself or in the pelvis are frequently mistaken for hydronephrosis, but in all such cases in which infection is present, the course of the disease is more rapid and acute in character and there is pus in the kidney urine from that side.

In cases of a perinephritic suppurative condition, there are always symptoms of sepsis and a lumbar incision is immediately indicated.

Cysts of the kidney, liver, spleen, mesentery and other abdominal organs have been mistaken for hydronephrosis, but they do not give rise to the urinary change. Hydatid or other cysts of the kidney may be suspected when urinary obstruction can be excluded and when a fluid circumscribed tumor exists. Hydatids of the liver may develop in any part of the organ and may resemble hydronephrosis when they appear on the postero-inferior aspect. Generally, hydatid cysts of any intraperitoneal organ can be traced by palpation or percussion to the organ with which they are continuous. There are not the same urinary changes and no obstruction to the ureter.

Ovarian Cysts.—These grow upward instead of downward as in hydronephrosis. Bimanual examination by the vagina and also in the loin will generally show us the difference. Hydronephrosis developing from a kidney displaced into the pelvic cavity has led in a number of instances to the removal of the organ (nephrectomy), mistaken for an ovarian cyst.

A localized accumulation of fluid in tuberculous peritonitis can be mistaken for hydronephrosis, as it may form a tumor in this region.

The completeness or incompleteness of the obstruction is determined by cystoscopy and ureteral catheterization. The site may be determined by the physical examination of the abdomen and by the examination of the urinary tract for ureteral obstruction or tumor in the bladder; while a history of renal colics would point to a calculus in the ureter on that side.

The state of the opposite kidney is determined by various methods of diagnosis described in the chapter on Renal Examination.

Prognosis.—The prognosis depends upon: (*a*) The cause of the obstruction, (*b*) the presence of compensatory hypertrophy, (*c*) the unilaterality of the hydronephrosis, (*d*) the liability to infection and (*e*) the possibility of surgical relief. As a rule, patients can go on for years with a hydronephrosis of moderate size, but there are always the dangers mentioned to be borne in mind.

Spontaneous atrophy, with complete obliteration of the sac, has been known to occur, but a return to the normal condition is impossible.

Treatment.—An acute attack of pain and retention occurring in the course of hydronephrosis should be treated palliatively by rest in bed and by the administration of morphin and other sedatives.

The *radical treatment* of hydronephrosis depends upon: (*a*) The cause of the obstruction, (*b*) the site of the obstruction, (*c*) the condition of the affected kidney, (*d*) the condition of the opposite kidney. The principles which must guide us in the choice of the method of treatment are: (1) We must preserve as much of the affected kidney as possible, and give the remaining parenchyma every possible chance to perform its function; (2) we must, if feasible, remove the cause of the obstruction rather than its effect; (3) we must not remove the diseased kidney unless its remnant is utterly useless, and unless the opposite kidney is positively known to be healthy.

The surgical measures that can be employed in hydronephrosis are:

1. Ureteral catheterization { (a) Catheter *à demeure.* (b) Washing out pelvis and ureter.
2. Puncture.
3. Nephropexy.
4. Operation to restore the ureter.
5. Nephrolithotomy.
6. Nephrotomy.
7. Nephrectomy.

These procedures are far from having the same value. We shall not discuss here nephrolithotomy, which comes under another heading.

Ureteral catheterization has had its day, in the treatment of hydronephrosis. The cases benefited by it all belonged to minor retentions due to movable kidneys.

Puncture should never be employed, as it is attended by risks of infection and an escape of the fluid into the peritoneal cavity.

Nephrotomy is indicated: (1) When, the opposite kidney being destroyed, it is absolutely essential to preserve those parts of the hydronephrotic organ which have been spared by the pressure of the retained fluid. (2) When hydronephrosis exists in both kidneys. (3) When the state of the opposite kidney is unknown. (4) When special circumstances exist which prevent the immediate removal of the obstruction to the urinary flow and there is hope of doing so at some future time; also when a renal calculus is present in the kidney or ureter. During nephrotomy, a ureteral catheter should always be passed from above downward for exploring or one from below upward for drainage.

The fistula remaining after nephrotomy is permanent, unless the operation is followed by a secondary nephrectomy or a plastic operation on the ureter. The edges of the sac should be stitched to the wound, including the lumbar muscles as in nephrostomy. Drainage may be secured by means of a tube.

All the above-mentioned methods may have given some success, but they are open to one capital objection, namely: That they do not remove the cause of the condition, thus classing them as mere makeshifts and not advisable procedures.

The same cannot be said of the three which are left: Nephrectomy, nephropexy, plastic operations and anastomoses on the ureter.

Nephrectomy removes the pathological renal condition, but also the remaining functionating tissue of the diseased organ. It should therefore be the last resort and should not be even considered unless the surgeon knows that the other kidney is sound. Primary nephrectomy must be reserved for those longstanding cases in which the tumor has reached a large size and appears cystlike, with thin walls and no surviving renal tissue. Secondary nephrectomy is indicated in the presence of a permanent fistula after nephrotomy, when the opened

diseased kidney is useless and the other organ sufficient to carry on the work of both.

Nephropexy and operations for restoring the ureters are then the operations of choice in the treatment of hydronephrosis, and are in conformity with the modern trend of renal surgery.

NEPHROPEXY should be the operation of choice in cases of hydronephrosis caused by abnormal mobility on the part of the kidney.

It is important in all cases to be sure that the ureteral kink is not fixed by adhesions and does not remain in spite of nephropexy; also that a ureteral catheter be introduced from below before operating. If no kink is felt at the time of operation, nephropexy is performed; but if a kink is felt, or the ureter is not inserted into the proper part of the renal pelvis, the condition of the ureter must be corrected before anchoring the kidney in proper position.

OPERATIONS FOR RESTORING DRAINAGE THROUGH THE URETER (pelvic ureteral operations) are in all respects the best when an obstruction is present, as it is evident that the preservation of some functionating renal tissue, even if but little, is worth some extra effort on the surgeon's part.

We do not intend to speak here of the operations on the continuity of the ureter—ureterotomy for stone, ureteroplasty for stricture, etc.—but will consider the treatment of the most common cause, that is, obstructive lesions in the upper part of the ureter, for which conditions special interventions have been devised. These are:

(1) The division of the spur between pelvis and ureter (kentrotomy) in case of abnormally high insertion of the latter.

(2) Ureteroplasty or correction of a stricture of the ureter based on the same principle as pyloroplasty.

(3) Uretero-pyeloneostomy or transplantation of the ureter itself, or of the ureter with an adjacent ring of pelvic tissue to the lowermost point of the sac.

(4) Lateral anastomosis of the ureter, or creation of a communication between the sac and the ureter below its obstructed part. This is recommended particularly when the first part of the ureter is markedly altered.

(5) Resection of the Pelvis.—The restoration of normal excretion of urine may also be brought about by the resection of the lower part of the sac, and anchoring the kidney in a suitable position, tilting its upper pole toward the median line, if necessary. This seems to be the best intervention when the ureter, after it has been freed from its adhesions, shows a normal lumen, which is very often the case.

(6) Pyeloplication or capitonnage of the exuberant pelvis is a good complementary measure, but insufficient when employed alone.

(7) In a few of the rare cases of hydronephrosis developed in an ectopic kidney in a low position, direct anastomosis between the bladder and the kidney has been successfully resorted to.

CHAPTER XXXI

OPERATIVE SURGERY OF THE KIDNEY

Operations

External exploratory.	Nephrostomy.
Internal exploratory.	Nephrectomy.
Pyelotomy.	Secondary nephrectomy.
Nephropexy.	Subcapsular nephrectomy.
Nephrotomy.	Partial nephrectomy.

The Routes

Extraperitoneal.	Intraperitoneal.

The Incisions

Vertical.	Oblique.
Transverse.	Curved.

Positions

Lying face down with an air pillow under abdomen.
Lying on back with sand bag or block under upper lumbar region.
Lying on healthy side with block, sand bag, or other support under loin.

Combination of Routes, Incisions and Positions

Extraperitoneal:

- Patient on abdomen. Incision vertical or curved along the outer border of the erector spinæ muscle, only recommended for bilateral nephropexy.
- Patient on back. Incision transverse from erector spinæ to rectus abdominis muscle (Pean's operation). Frequently used.
- Patient on the healthy side. Incision vertical, curved, oblique or transverse. The curved incision is the best.

Intraperitoneal.—Patient on back. Vertical incision along the outer border of the rectus abdominis muscle. Not recommended.

The extraperitoneal operation performed through a curved incision in the loin with the patient lying on the healthy side affords the best means of operating on ninety per cent of the cases requiring operation. It is the one that will

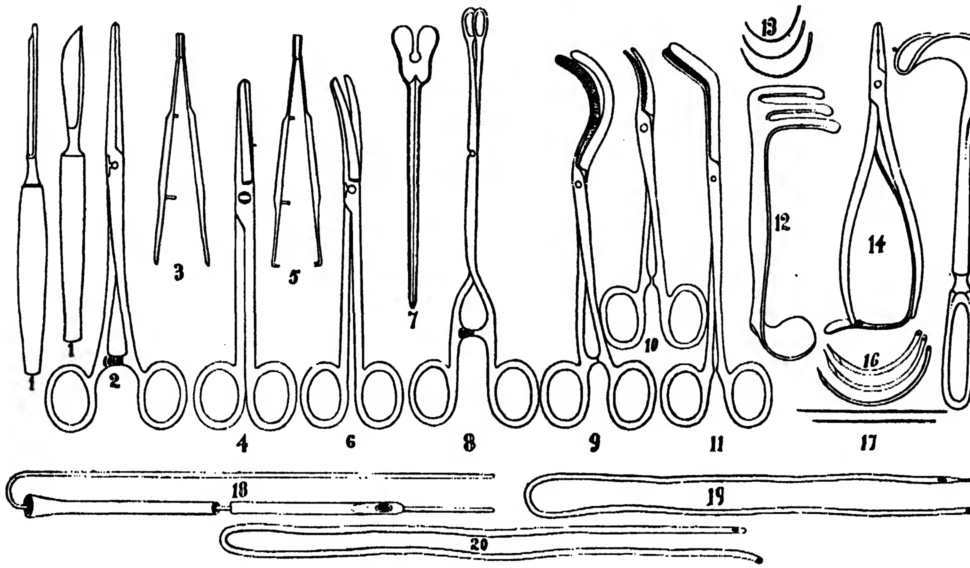


FIG. 322.—INSTRUMENTS USED IN OPERATIONS ON THE KIDNEY.

1, Scalpel and probe-pointed bistoury.
2, Straight pedicle clamp.
3, Thumb forceps.
4, Straight scissors.
5, Mouse-tooth forceps.
6, Curved scissors.
7, Grooved director.
8, Sponge-holding forceps.
9, Curved pedicle clamp.
10, Artery clamp.
11, Angular pedicle clamp.
12, Guiteras kidney retractor.
13, Intestinal cylindrical curved needles.
14, Needle holder.
15, Guiteras abdominal retractor.
16, Hagedorn needles.
17, Straight needles.
18, Fenestrated ureteral catheter and guide.
19, Probe-pointed ureteral catheter.
20, Blunt-pointed ureteral catheter.

principally be considered in this chapter. The instruments used in renal surgery are shown in Fig. 322.

Throughout the text, the kidney angles and triangles will be occasionally spoken of. The posterior kidney angle is at the junction of the erector spinæ muscle and the twelfth rib. The posterior kidney triangle is formed by the continuation of the lines making the triangle until they meet the umbilical line. In Fig. 323, the inner side of the triangle which corresponds to the outer border of the erector spinæ muscle is $3\frac{1}{2}$ inches long (*A–B*). The outer side of the triangle corresponds to the lower border of the twelfth rib $2\frac{1}{2}$ inches, and a line continuing from its tip to the umbilical line 2 inches more, making $4\frac{1}{2}$ inches (*A–C*). The base along the umbilical line would be about 3 or more inches (*B–C*). The umbilical kidney line extends around the body at the level of the upper border of the umbilicus and corresponds to the lower border of the right kidney. The deep markings of this triangle vary according to the size of the

erector spinæ muscle, the slope and length of the twelfth rib and the length of the ileo-costal space. The surface markings vary according to the amount of fat in this region.

The anterior kidney angle in front is at the junction of the outer border of the rectus abdominal muscle and the free border of the ribs which correspond to the tip of the ninth costal cartilage. (See Fig. 324.) The anterior kidney triangle is formed by the continuation of the lines going to form the kidney

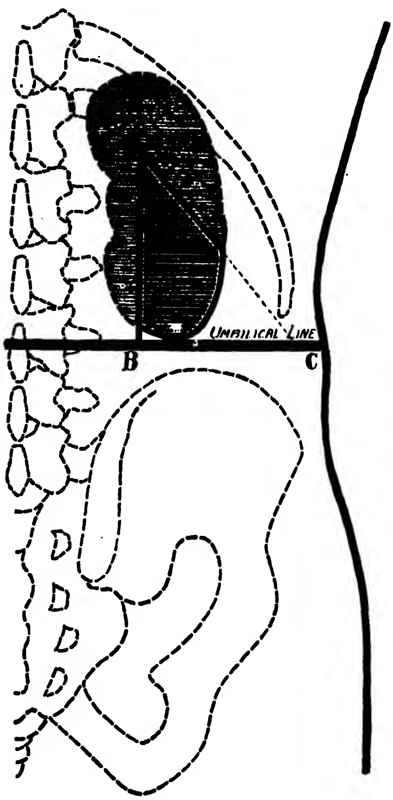


Fig. 323.—Posterior Kidney Angle.

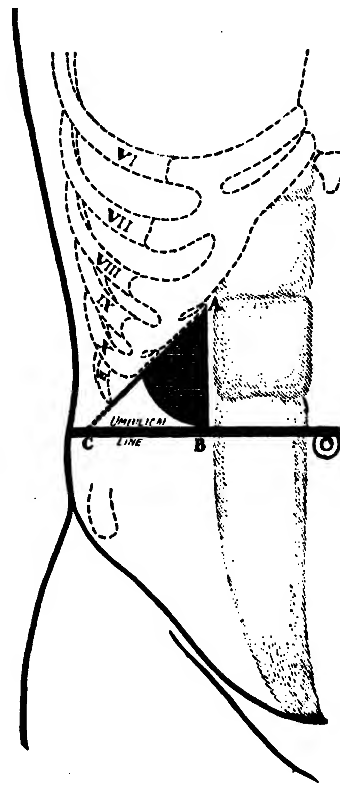


Fig. 324.—Anterior Kidney Angle

angle to the umbilical line (A–B–C). The inner border is $2\frac{1}{2}$ inches long along the outer side of the rectus abdominis muscle (A–B) and the outer $3\frac{1}{2}$ along the costal margin and continued to the umbilical line (A–C). The length of the base (C–B) corresponds to the size and the rounding of the body. These measurements vary greatly in different individuals and are the result of an average made from a number of cadavers while teaching anatomy in 1894.

INCISIONS

Vertical Incisions.—The POSTERIOR VERTICAL INCISION is one made with the patient lying face downward with a pillow, sand bag or some other support

under the abdomen. It begins at the apex of the posterior kidney angle, that is, the junction of the twelfth rib and the erector spinæ muscle, and extends down along the outer border of the erector spinæ muscle (Fig. 325). It is the one usually used in performing nephropexy, although the vertical incision can be made equally well with the patient lying on the side opposite the kidney to be operated upon. The posterior incision has the advantage, however, in performing a double nephropexy, as then the position of the patient does not have to be changed during the operation.

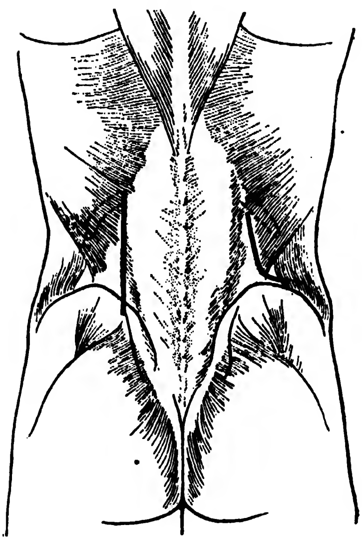


Fig. 325.—Posterior Vertical Incision Seen on the Left and the Short Curved Incision on the Right.

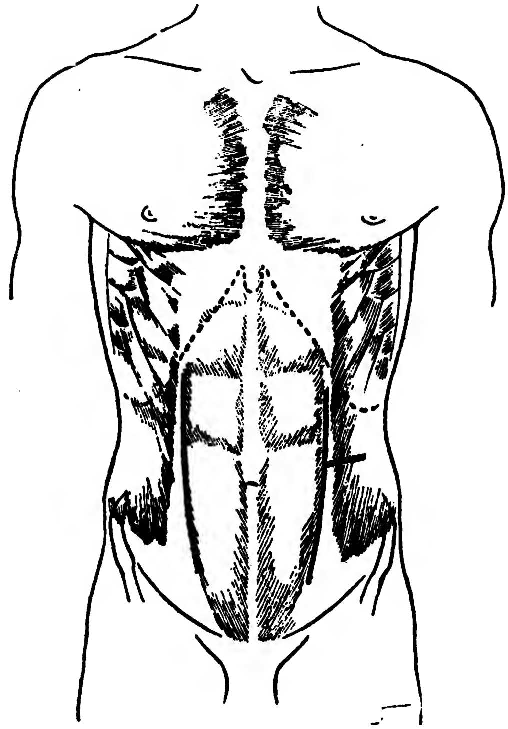


Fig. 326.—Anterior Vertical Incision Seen on the Right Side and the "Modified" Incision on the Left.

Anterior Vertical Incision (Fig. 326).—The anterior incision is made with the patient lying on the back with a support underneath the vertebræ. It begins at the anterior kidney angle, that is, at the juncture of the ninth costal cartilage and the rectus abdominis muscle, and extends downward along the outer side of this muscle to a point two inches below the umbilical line. This incision is used principally for removing the kidney through the peritoneum in cases of a large renal tumor. Sometimes a short incision is made outward from the main incision, at right angles to it, when more space is needed.

Lumbar Incision.—The lumbar incision with the patient lying on one side is the one generally used in this country and may be either transverse, vertical, curved or oblique.

TRANSVERSE.—The transverse incision is usually made with the patient lying on the back in the same position as for the anterior incision, and extends along the umbilical line from the erector spinæ to the rectus abdominis muscle (Fig. 327). It is also made with the patient lying on one side.

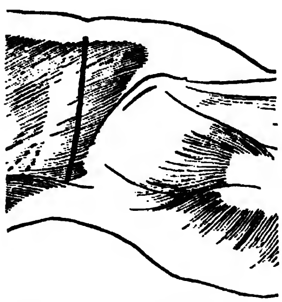


FIG. 327.—TRANSVERSE INCISION. The patient lying on the back or side.

VERTICAL.—The vertical incision is made in the same way when the patient is lying on the side as when lying on the abdomen. It is rather small for extensive operations and is used principally for fixing in place a movable kidney and for exploring the organ. (See Fig. 325.)

CURVED.—The curved lumbar incision is the most conservative, as well as the most economical as far as the expenditure of tissue is concerned. Here the incision begins as a vertical one and extends down nearly to the crest of the ilium (Fig. 328), where it begins to curve toward the anterior superior spine of the ilium, sometimes passing it when more space is needed, as is frequently the case when a nephrotomy or a nephrectomy in pathological kidneys is being performed. Care must be taken, in making this incision, not to go too near the crest of the ilium, as in such a case it is more difficult to close it satisfactorily afterwards. This incision can be continued for any distance, even along the rectus abdominis muscle to the pubes.

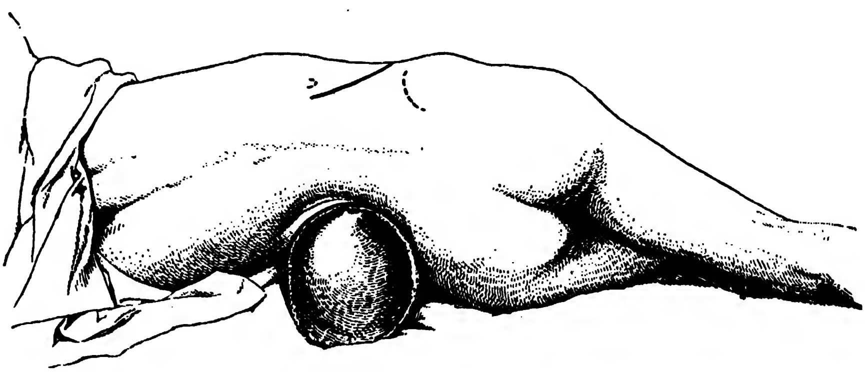


FIG. 328.—CURVED LUMBAR INCISION. The position preferred in renal surgery.

OBLIQUE.—The oblique incision begins at the erector spinæ muscle, one inch below the twelfth rib, and

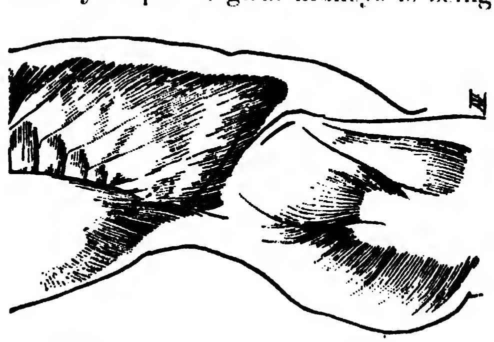


FIG. 329.—OBLIQUE LUMBAR INCISION. The patient lying on one side.

extends in a direction parallel to this rib as far as necessary to complete the operation. It is a very good incision, but does not leave the abdominal wall strong, as does the curved one (Fig. 329).

Posterior Vertical with Curved Lumbar Incision.—The incision used in describing the following operations will be the posterior vertical, to be continued into the curved lumbar when more space is needed.

The POSITION of the patient in making this lumbar incision is lying upon the healthy side with the arm and thigh of that side flexed, as is shown in Fig. 328. Sometimes the thigh of the healthy side is extended and the one on the side of the operation is flexed and the knee rests on a sand bag. The first of the

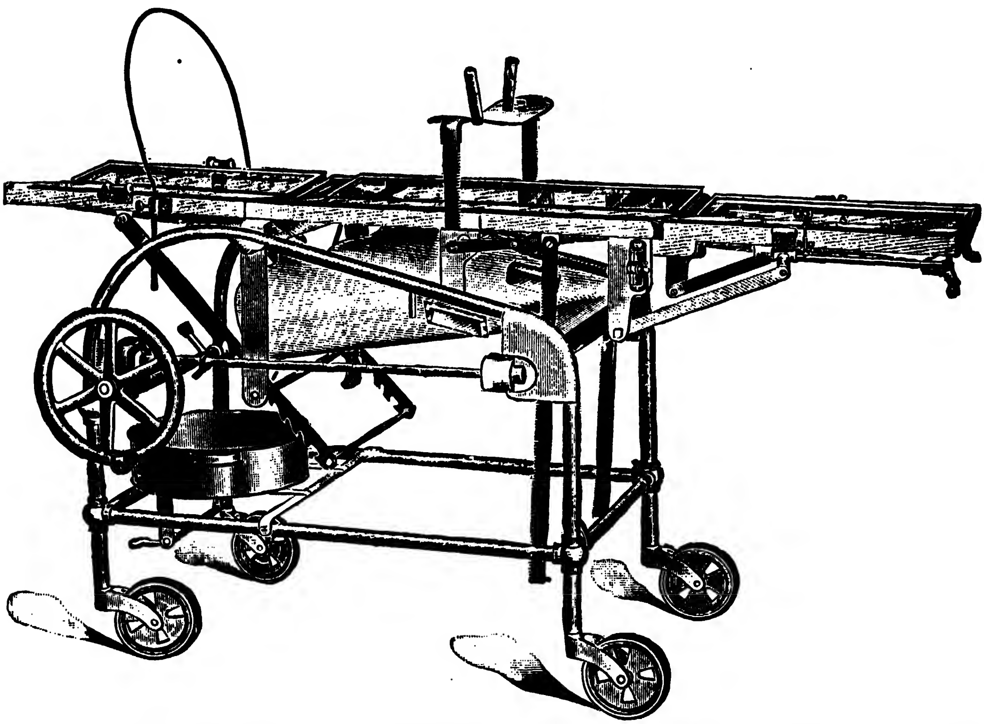


FIG. 330.—OPERATING TABLE. This has a transverse iron plate running across it that can be elevated to any distance for regulating the patient's position. The pegs in the iron plate prevent the body from slipping.

two positions is, however, preferred. A support should be placed on the table under the healthy side of the patient of such a size and shape that it will separate as far as possible the space between the border of the ribs and the ilium of the side to be operated. This support should not be so high, however, as to push the healthy shoulder or hip of the patient above the level of the table, but only a sufficient distance to stretch the field of operation. Once in place, sand bags should be placed about the body in such a way as to retain it in the desired position. Very often, pulling on the kidney or leaning on the body tends to push the patient out of position unless sand bags are used. The

support under the healthy loin, which I have spoken of, may be a sand bag, a cushion, one or two bricks, a log, a small back rest, or some support which is sufficiently narrow to catch in the ileo-costal space. A wedge-shaped support

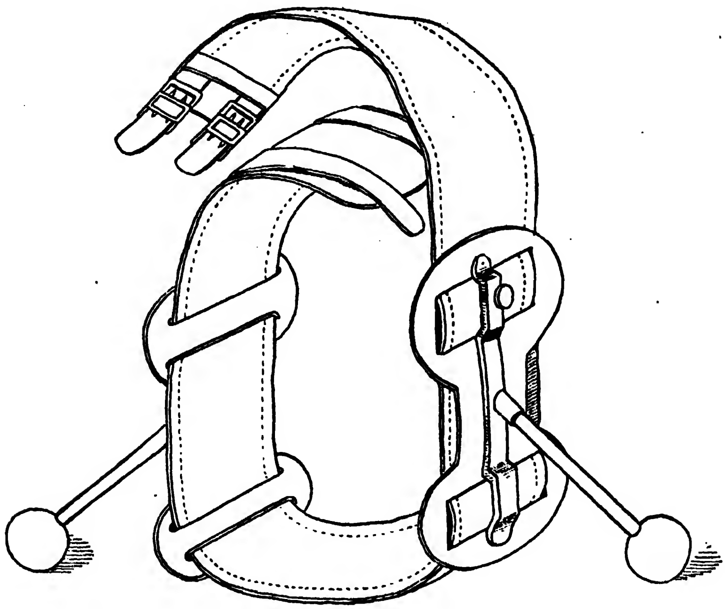


FIG. 331.—BODY HOLDER FOR PREVENTING THE PATIENT FROM ROLLING WHEN LYING ON THE SIDE. The rods extend out obliquely in front and behind and rest on the table.

sometimes fits admirably in this space. Many of the tables now used for operations have a slab extending across them, that can be elevated to any degree desired, which graduates the position of the patient better than any other method (Fig. 330).

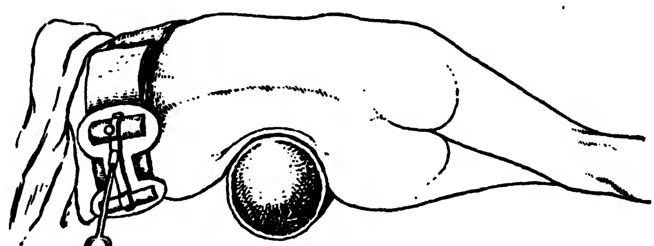


FIG. 332.—THE BODY HOLDER ON THE PATIENT, TO PREVENT HIM FROM ROLLING.

Body holders are also constructed to hold the body in the desired position and prevent the patient from rolling during the operation (Fig. 331). The body holder is made of a wide canvas belt to which two iron bars are attached by clasps. When this is strapped about the body below the axillas, the bars extend out obliquely to the surface of the table on either side and hold it firmly in place (Fig. 332).

In describing surgical operations on the kidney, I shall first show them as they are performed by the lumbar incision with the patient lying on the healthy side, as operations in adults, excepting double nephropexy, can be performed by this route better than by any other. In renal tumors in children, the abdominal route is the one of choice. In adults, I have never as yet had to resort to it, the curved lumbar incision always having answered the purpose.

Technique of Operation.—I think that, for the sake of clearness, it is advisable for me to describe first the kidney operation according to my routine method and then to take up those preferred by other surgeons.

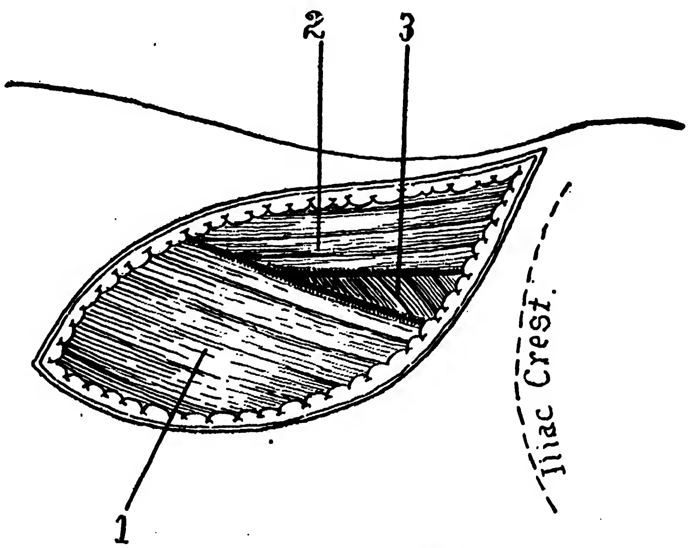


Fig. 333.—Incision through the Skin and Superficial Fascia, Revealing Petit's Triangle. (1) Latissimus dorsi behind. (2) External oblique in front and the iliac crest below. Its floor is the internal oblique (3).

The technique of operations by the curved incision in the loin is as follows: The incision is begun one inch above the apex of the kidney angle, that is, just above the twelfth rib, and extends down along the outer border of the erector spinæ muscle to within one and a half inches of the crest of the ilium, at which point it should be curved toward its anterior superior spine (Fig. 328). The skin is first cut through and, with the fatty tissue, is dissected back on either side for half an inch, so as to leave sufficient space of exposed external fascia for the passing of sutures in closing the wound. The latissimus dorsi and the external oblique are then seen forming Petit's triangle below (Fig. 333.). The latissimus dorsi muscle and the superficial fascia should then be incised along the outer border of the erector spinæ muscle which can easily be outlined. The serratus posticus inferior, the erector spinæ, the oblique muscles, the twelfth rib, the lumbar fascia are then seen (Fig. 334). The serratus posticus inferior, the external and internal oblique and the deep lumbar fascia are then cut through

(Fig. 335) and some of the lumbar nerves are seen. The kidney region is here clearly disclosed. The deeper part of the incision should be made in this space

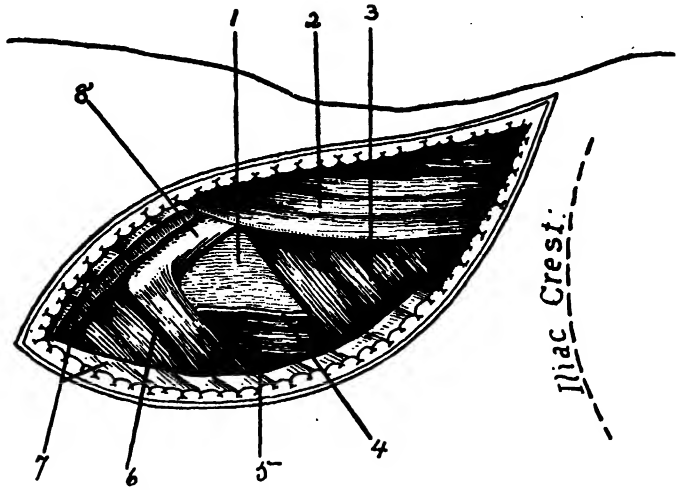


Fig. 334.—Incision through Latissimus Dorsi Muscle (7), showing Beneath It: (1) The transversalis fascia; (2) the external oblique muscle; (3) the internal oblique; (4) the bifurcation of the transversalis fascia; (5) the erector spinæ muscle; (6) the serratus posticus inferior and (8) the

from the rib downward along the outer side of the quadratus muscle, and through the internal lumbar fascia. On cutting through this fascia, the fatty capsule is seen (Fig. 336). The incision in the fascia is prolonged and the

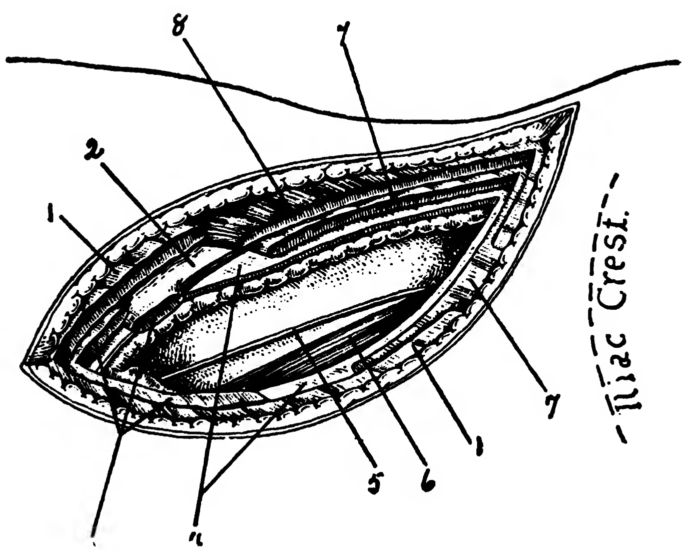


Fig. 335.—Muscles (1, 3, 4, 7 and 8) Cut Through; That Is, the Latissimus Dorsi, the Serratus Posticus Inferior, the Transversalis, and the Internal and External Obliques. The twelfth rib (2) is seen on the outer side, (6) the quadratus lumborum on the inner side. The deep fascia with (5) the lumbar nerves (the ileo hypogastric and the ileo inguinal) are also seen.

fatty capsule is grasped by sponge forceps and cut through, disclosing beneath it the kidney covered by its capsula propria. The organ usually moves up and down with inspiration and expiration. Preparations are now made for performing renal explorations and operations.

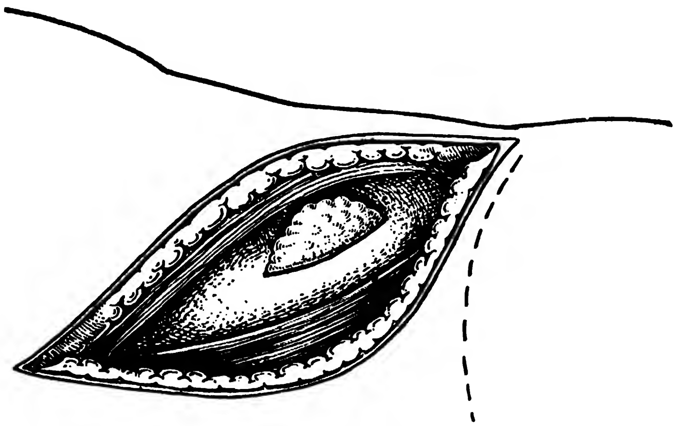


FIG. 336.—DEEP LUMBAR FASCIA CUT THROUGH, SHOWING THE FATTY CAPSULE OF THE KIDNEY.

FREEING AND DELIVERY OF A KIDNEY.—The forefinger or the fore and middle fingers of one hand are now inserted between the fatty capsule and the capsula propria on the posterior part of the kidney, with the palmar surface

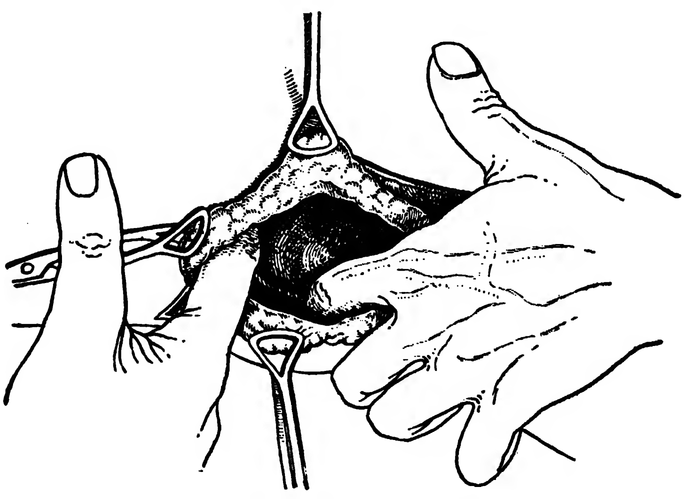


FIG. 337.—FREEING THE KIDNEY. The fatty capsule is caught with sponge forceps, the kidney is brought into the wound while the fatty capsule is separated from it by the forefingers working on either side of the kidney at the same time.

next to the organ, while the forefinger of the other hand is introduced between the two capsules in front. The fingers then move to and fro over the renal surface in opposite directions, pushing the fatty capsule away from the organ (Fig.

337). Sometimes this is easily done, while again difficulties are encountered on the anterior surface and at the upper and lower poles. In the case of a kidney that is movable but not pathologically diseased, the freeing of the organ is quite easy and very often, after the fatty capsule has been incised, its sides can be grasped and the kidney pulled down until its upper pole is below the twelfth rib and then lifted out of the wound as a sling with the kidney within it (Fig. 338). At other times the lower leaflet of the perirenal fascia can be grasped with sponge-holding forceps and pulled down, while the forefinger of one hand is placed under the lower pole of the kidney and it is hooked out (Fig. 339). The lower pole is then grasped by the fingers of the right hand and steadied, while the forefinger of the left hand is passed under the upper pole, and lifts it out of its cavity and over the twelfth rib (Fig. 340).

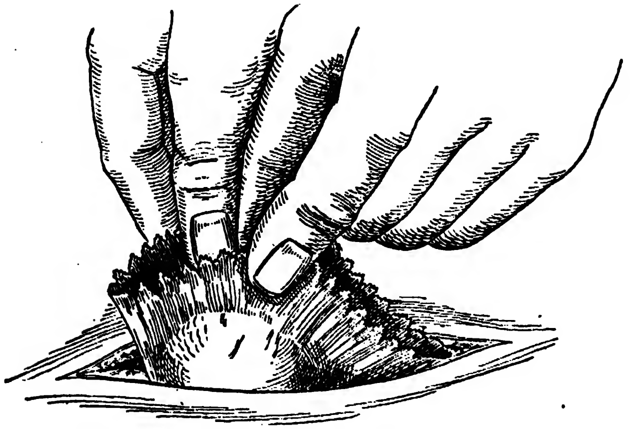


Fig. 338.—Delivery of the Kidney. This is often quite easy in cases of movable kidney as the kidney is grasped by its fatty capsule, pulled down until its upper pole is below the ribs, when it is pulled up and out over the rib. (After Ashton.)

In case it is easier to deliver the upper pole first, it is steadied by the fingers of the left hand while the forefinger of the right hand is passed under the lower pole and hooks it out.

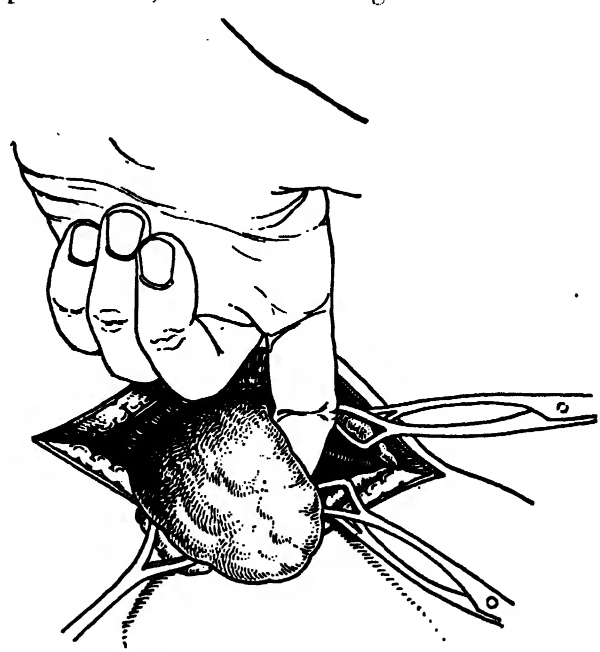


Fig. 339.—Delivery of the Kidney. When the lower pole is hard to deliver, the forefinger is placed beneath it and hooks it out.

In the case of a pathological kidney, however, there are often very great difficulties in freeing the organ on account of the dense adhesions and the lack of mobility on the part of the kidney. In the first place, the adhesions between the fatty capsule and the capsula propria

are at times so dense that they cannot be separated, in which case the kidney has to be delivered without either of its capsules, or else an extensive dissection has to be made through the combined fatty capsule and capsula propria. A thick mass of fat also extends up and down along the leaflets of the perirenal fascia, often forming dense tissue above and below the organ. In such cases, it is necessary at times to cut through this dense tissue; but before doing so, it is important to free the kidney as much as possible and it is often necessary to insert the entire hand through the incision and,

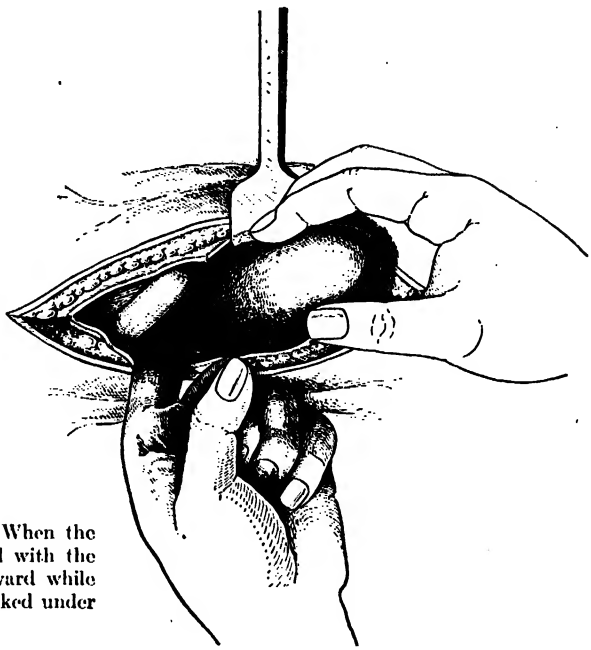


FIG. 340.—DELIVERY OF THE KIDNEY. When the lower has been delivered, it is grasped with the fingers of one hand and pulled downward while the forefinger of the other hand is hooked under the upper pole and draws it out.

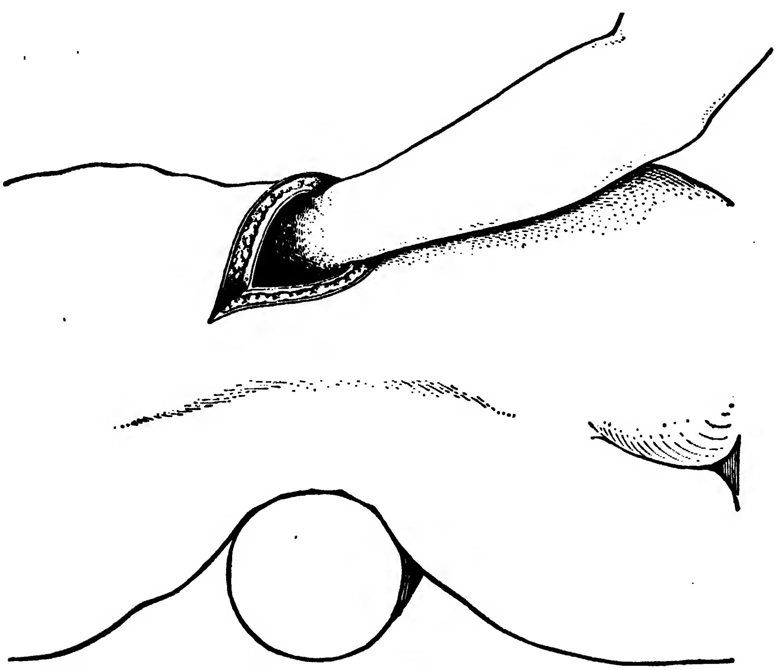


FIG. 341.—DELIVERY OF THE KIDNEY. In many cases it is difficult to draw the kidney down and it is necessary to insert the hand into the wound until the fingers are above the kidney to loosen its pole before bringing it down. It is then delivered in the way already explained.

having reached the fingers above the kidney, to free the organ gently until it can be brought down into the operative field (Fig. 341).

Cutting through these masses of tissue often gives rise to considerable hemorrhage and is sometimes a very alarming procedure to the practitioner who is doing his first kidney operation for stone, tumor or tuberculosis, as in these classes of cases, especially the first, the sclerosis is most marked. He must not hurry, however, or become flustered, but must remember to shut off the vessels by clamps and ligatures before cutting through the tissue above and below the kidney. In ligating this mass, it is advisable to clamp the tissue and then to pass ligatures, threaded on a needle by the aid of a needle holder outside, above or below the clamps, allowing sufficient space for cutting through the tissue between the ligatures and the kidney. In this way, the ligatures have a better hold on the tissue and bleeding is controlled.

In cutting through and tying off this tissue below the kidney, the operator must be careful not to include the ureter in the ligature. It is therefore advisable, in the case of a dense mass of tissue below the lower pole in the region of the ureter, first to find the ureter and dissect up along it to the pelvis of the kidney and then to free and retract it while the kidney is being liberated. In fact, it is always advisable in any operation on the kidney to have control of the ureter at an early period of the work. After having freed the ureter up to the pelvis of the kidney, the back of the forefinger is placed against the anterior surface of the ureter and it is then pushed up to the pedicle. The forefinger should then be turned and hooked behind the pedicle, and its tip brought out above it, pointing forward. The pedicle will then be under complete control, which will assist in freeing the anterior adhesions and preventing any traumatism of the vessel.

EXPLORATIONS AND OPERATIONS

External Exploration of a Pathological Kidney.—A cystic kidney can be determined by the irregular cystic protuberances over its surface, showing cystic degeneration, or, in case of a large serous cyst, by a large sac. A tumor can be detected by the enlargement of the organ and the increased consistence and nodular feel of the new growth. A tuberculous kidney is enlarged and reddened with hard and bulging areas, in places in an acute condition; whereas, if the kidney is quite extensively destroyed by a suppurative process, the color is lighter and the surface is more irregular and soft areas may be felt on the outside, which are abscesses or abscess cavities. If there is much pus in the pelvis or in cavities of the kidney, it may have a mushy feel. Groups of tubercles may also be seen beneath the capsula propria. In case of a stone in the kidney, the organ is usually very much indurated, somewhat enlarged and has considerable fat about it; while in a suppurative case, there might be considerable enlargement

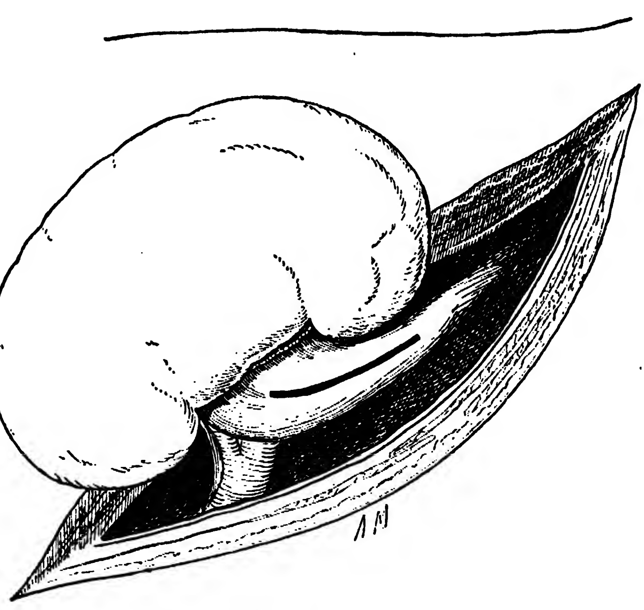
through retention of pus or pus and urine, making it difficult to detect the calculi.

Aspiration.—In case there is a retention of pus or urine in the kidney which enlarges it to such a degree that it cannot be easily delivered, an aspirating needle can be inserted and sufficient fluid removed to allow freer manipulation of the organ, and a sufficiently satisfactory palpation can be made to detect the presence of calculi.

In aspirating, it is advisable to have the outflow nozzle of the aspirator connected with a tube, in order that the aspirated fluid may be pumped into a receptacle held outside of the operative field.

Internal Exploration of the Kidney.—*Pyelotomy* is another name for an incision of sufficient size to admit the forefinger in the renal pelvis, and should be made on its posterior surface from near the kidney downward in the direction of the ureter. The operation is really an exploratory one and is indicated in aseptic cases in which a stone in the renal pelvis is suspected.

Technique. The kidney is delivered and pushed over the upper border of the incision in such a way as to put the pelvis on the stretch. It is then steadied with the left hand, while the pelvis is incised by the knife in the right hand. The incision is made from near its junction with the kidney longitudinally toward the ureter to a sufficient extent to allow the end of the forefinger to enter (Fig. 342). The finger, having been introduced into the pelvis, explores its cavity and the tip is inserted into the different calices, by which means a stone can be easily detected and if small can be withdrawn without difficulty with curved forceps. If no stone is present, the incision can be closed by a Lembert suture. This is a simple procedure in a thin individual in whom plenty of space is present, and is attended by very little bleeding. The operator must be very careful not to cut through both sides of the pelvis in making the incision, for the tissues



ig. 342.—Examination of the Kidney. The kidney after delivery is examined by palpation and sometimes the pelvis is opened longitudinally, pyelotomy, and the forefinger introduced palpates its calices.

are on the stretch and the anterior and posterior walls are often flattened on one another.

It is safer to have an assistant steady the kidney with one hand and then for the operator and the assistant to pick up the wall of the pelvis with thumb forceps and cut between them.

Further internal exploration of the kidney requires a vertical incision through its convexity which will allow us to see calculi or tubercular nodules or abscess cavities. This operation will be considered later under nephrotomy.

Nephropexy.—There are very many operations for fixing a movable kidney, but I shall describe only my own operation, which was formulated by me to cover the different difficulties that are met in anchoring the organ.

TECHNIQUE OF NEPHROPEXY.—The patient should be placed either face down with a pillow under the abdomen, or else on the healthy side with a sand

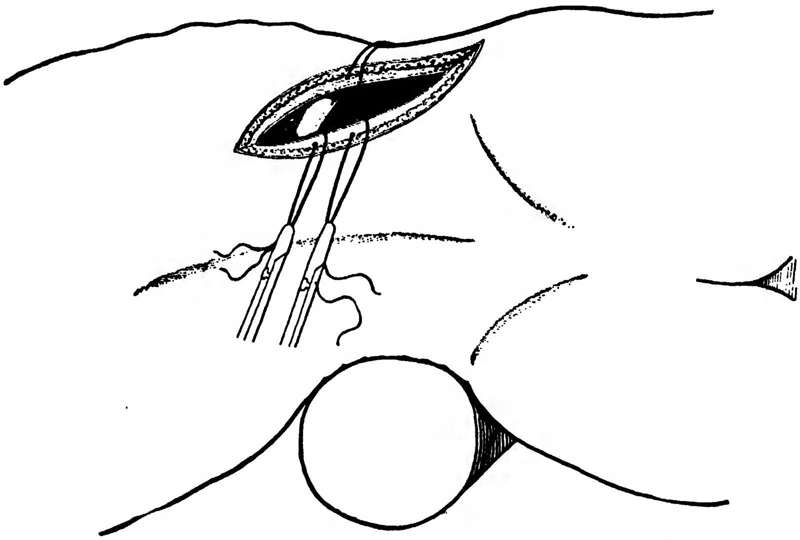


FIG. 343.—OPERATION FOR MOVABLE KIDNEY. The fixation sutures are passed through the abdominal wall before the kidney is delivered and then hang on either side of the patient while the kidney is being operated on.

bag or some other support under the loin. The latter position will be considered, as it is much easier to describe first all the operations that can be done in this position. The incision is the vertical one already shown, to be curved if necessary. (See Fig. 325.) Before delivering the kidney, I pass the fixation sutures through the abdominal wall excepting the skin, two fixation sutures through the muscles and fascias on the inner side of the incision below the twelfth rib and one through the outer side (Fig. 343). The first suture is passed through the erector spinæ muscle and other muscles and fascia just below the twelfth rib, and the second or lower one is passed through the same tissues about one inch below the upper one. The third fixation suture is passed through the abdominal on

the inner side of the incision in a space corresponding to that between the sutures on the outer side. It is impossible to put in two traction sutures on either side of the incision that will hold it up at equal distance without either twisting the kidney or going through the pleura, the eleventh intercostal space, or the corresponding rib; therefore, as the object of nephropexy is to anchor the kidney as near as possible to its normal position, it is better to put but one fixation suture through the inner side of the incision. The ends of each fixation suture are clamped together and are allowed to hang over the side of the body until further needed.

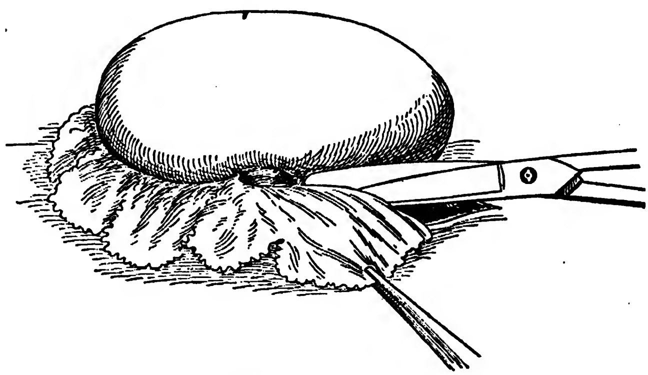


FIG. 344.—OPERATION FOR MOVABLE KIDNEY. The kidney is then delivered and the whole of the fatty capsule behind the kidney and half of it in front of the organ is cut away. (After Ashton.)

The kidney is then delivered in the manner already described. A movable kidney is easily delivered on account of its long pedicle. The operator can often simply lift it out of its fossa by grasping the fatty capsule on either side and pulling the organ first downward beneath the iliac crest and then shooting the upper pole over the twelfth rib to the surface of the body, after which the lower pole is delivered.

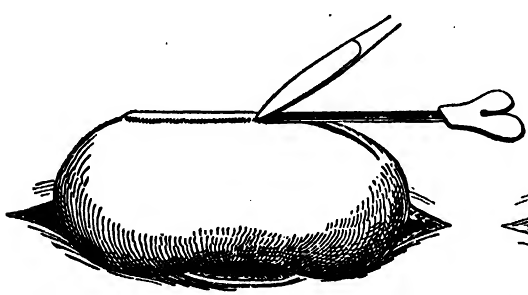


FIG. 345.—OPERATION FOR MOVABLE KIDNEY. The capsula propria of the kidney is then nicked in the middle of its convexity and a grooved director is pushed beneath it up as far as the upper pole, after which it is cut through. The capsule is then slit in the same way down to its lower pole.

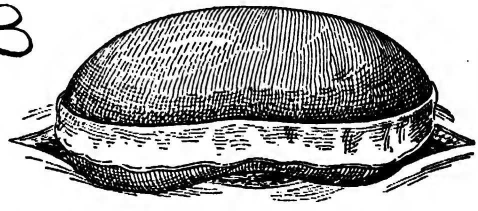


FIG. 346.—OPERATION FOR MOVABLE KIDNEY. The kidney capsule on the back of the kidney is then reflected halfway to the hilum by gently drawing it down with thumb forceps until half of the posterior surface is bare. The capsula propria over the anterior surface of the organ is not disturbed.

In twenty-five per cent of the cases I operated upon, the kidney was markedly enlarged; ten per cent were lobulated and indurated. In some cases, the hepatic flexure and the ascending colon were adherent and accompanied the kidney on its excursions. Adhesions to surrounding tissues were present in a number of patients. The separation of adhesions and the decapsulation caused varying amounts of hemorrhage in the different cases.

The whole of the posterior side of the fatty capsule on the posterior surface of the kidney should then be cut away and about one half of its anterior surface (Fig. 344).

The capsula propria should now be split from pole to pole over the convexity by making a small incision through it and then passing a grooved director beneath it as far as the upper pole and cutting through the capsule on to the groove with a knife. The cut is also made down to the lower pole in the same way.

The posterior capsule is reflected down toward the pelvis until one half of the organ is decapsulated. The capsula propria over the anterior part of the organ should remain intact (Fig. 346).

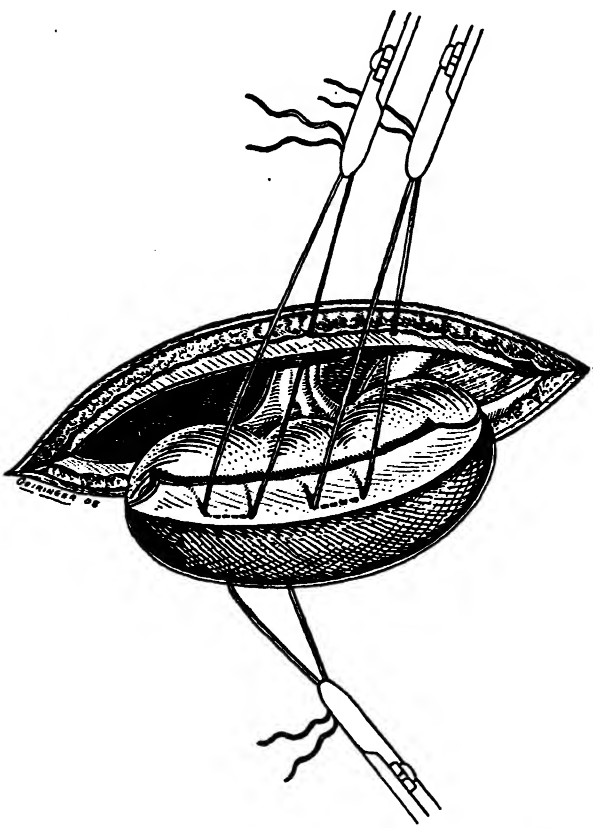


FIG. 347.—OPERATION FOR MOVABLE KIDNEY. The posterior fixation sutures are passed through the doubled capsule of the kidney.

The explanation of this is as follows: Over the posterior surface of the kidney, no fatty capsule is needed, as it will prevent the kidney from adhering and growing to the posterior abdominal wall. The capsula propria is reflected back, because it enables the kidney tissue to come in closer contact with the posterior abdominal wall and to form a firmer union.

The anterior surface of the capsule is not reflected because it is not desired to have the anterior surface become any more adherent to the soft tissue than is natural. The anterior layer of the fatty capsule is half dissected away to prevent a redundancy which might overlap the convexity of the kidney and interfere with the adhesion between the posterior wall of the kidney and the abdominal wall.

The sutures Nos. 1, 2 and 3, which have already been passed through the walls of the incision, are now passed through the capsule. No. 1 is passed through the posterior layer of the capsula propria, both the reflected layer

and the part of the capsule on to which it has been reflected, thus making it doubly strong. It enters the doubled layer of capsule at the junction of the upper and middle third, passes between the capsule and the kidney parenchyma and comes out through the capsule three quarters of an inch below. Suture No. 2 is passed through the two layers of capsule just below No. 1, in the same way (Fig. 347). The fixation suture on the inner side is passed through the anterior half of the kidney capsule. It enters at the middle

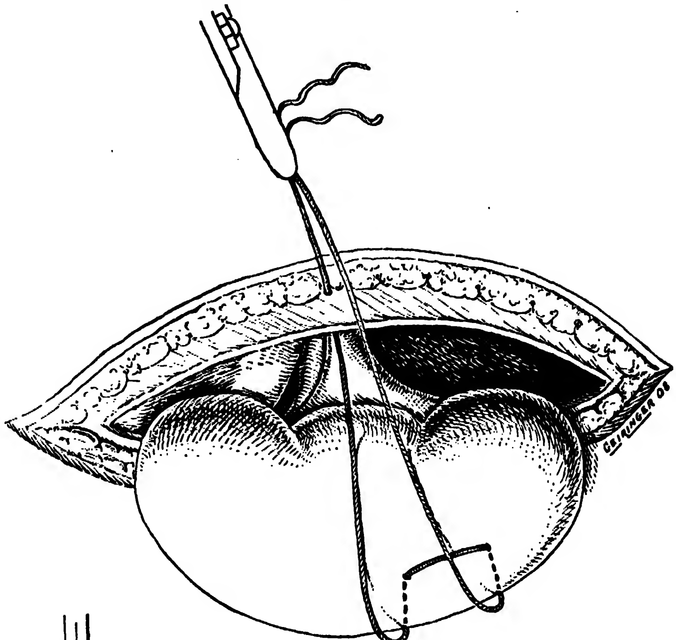


Fig. 348.—Operation for Movable Kidney. The anterior fixation suture is passed between the capsule and cortex of the kidney, as indicated by dotted lines, and over the outside of the capsule, as is shown by the continuous line.

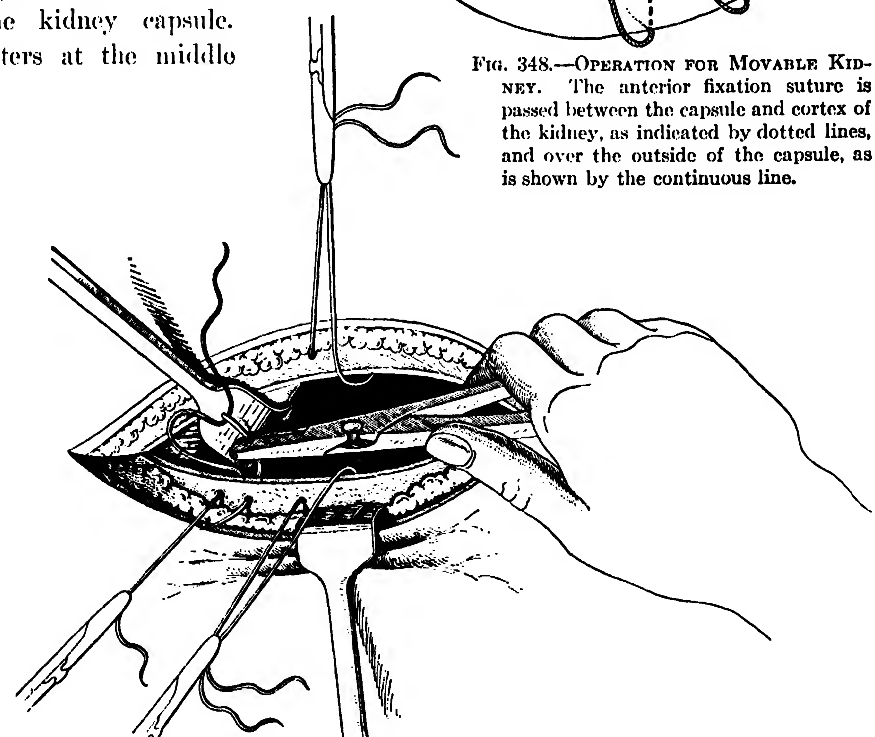


Fig. 349.—Operation for Movable Kidney. The kidney is now pushed back again into the renal fossa and the fixation sutures that have just passed through the renal capsula propria are again passed through the abdominal wall half an inch below where they entered. The abdominal wall is here depicted very much thinner than it should be.

of the convexity of the kidney, between the anterior layer of the capsule and the renal parenchyma, and passes transversely beneath the capsule for three quarters of an inch. It then pierces the capsule and is carried down along its outer surface for three quarters of an inch, where it again pierces the capsule and emerges from beneath it at the edge of the convexity again (Fig. 348).

The kidney should now be pushed back into its fossa again with the free ends of the sutures, that have passed through the abdominal wall and the cap-

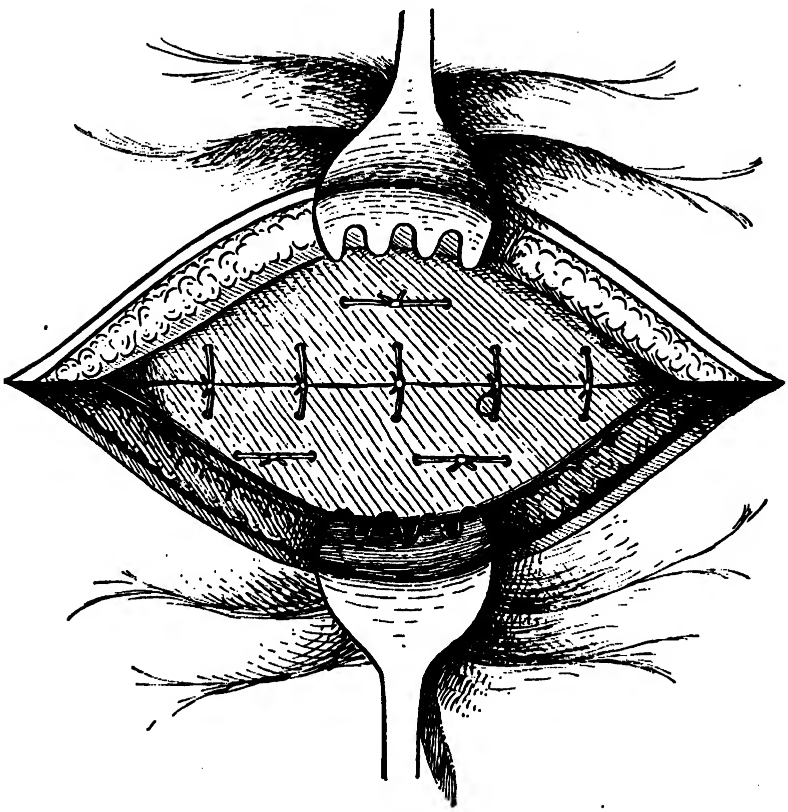


FIG. 350.—OPERATION FOR MOVABLE KIDNEY. The muscles and fasciæ of the abdominal incision are then closed by interrupted sutures. The fixation sutures are hauled taut and tied over the external layer of lumbar fascia and the skin is brought together over them.

sule, clamped and hanging loosely. Then the free ends of the sutures on Nos. 1, 2 and 3 are threaded on Hagedorn needles and passed through the abdominal wall from within outward through internal fascia, muscles and external fascia (Fig. 349), half an inch beneath the point at which they were inserted, and then the two ends of each suture are clamped together again. The sides of the incision are then sutured together, the deep fascia sewed, then the muscles and the superficial fascia. The kidney is now anchored by drawing the fixation

sutures taut and tying their ends together (Fig. 350). This should be done with great gentleness to prevent tearing the capsule or disturbing the relations with the posterior abdominal wall, which are exactly correct for a good apposition (Figs. 351, 352, 353).

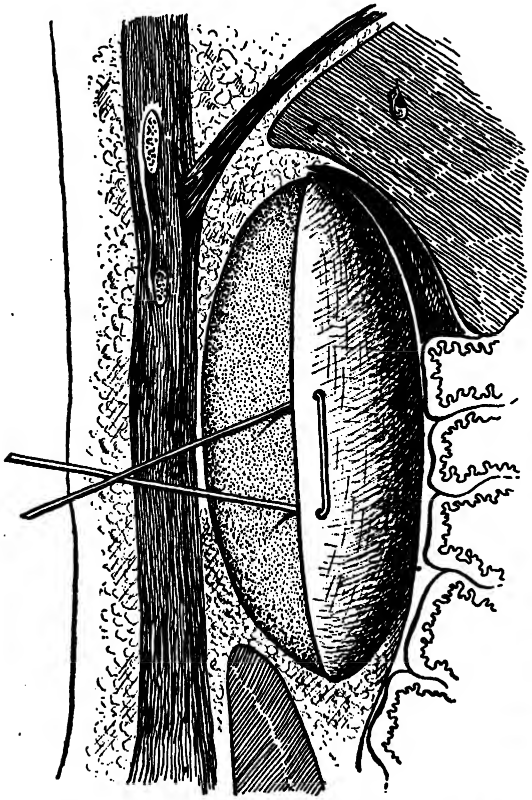


Fig. 351.—Side View of the Convexity after Anchoring the Kidney.

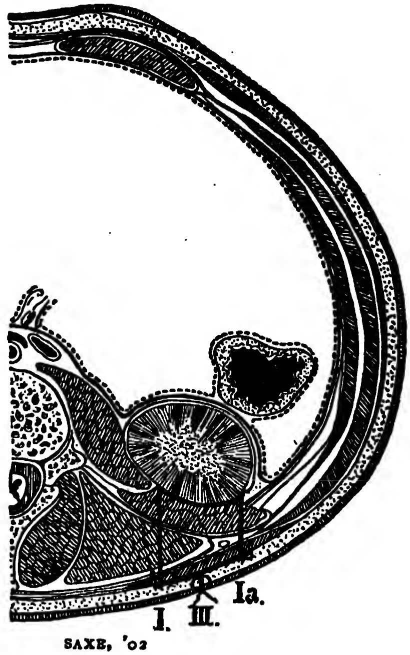


Fig. 352.—Sectional Posterior View after Anchoring the Kidney. *I.* Posterior fixation suture. *Ia.* Anterior fixation suture. *III.* Line of the incision union.

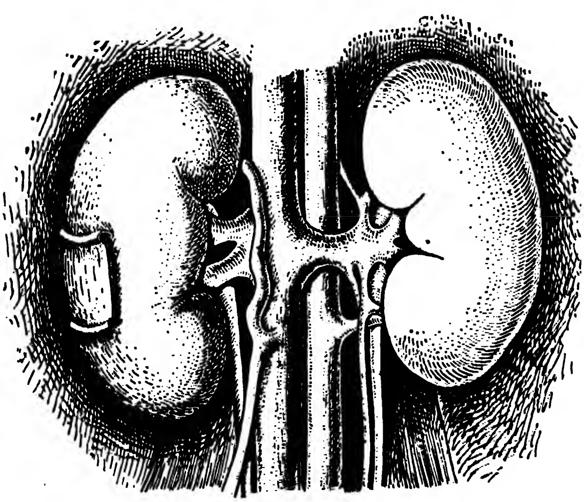


Fig. 353.—Anterior View after Anchoring the Kidney.

After the abdominal wall has been brought together and the sutures tied, the skin is closed by interrupted sutures tied well to the outside of the incision.

After-treatment of Nephropexy.—In order to have a good result, the patient should lie in the dorsal position for three weeks with no pillow under the head. The discomfort of not changing position is very great, but it is imperative if success is desired.

During the operation for nephropexy, there are rarely any difficulties encountered. Sometimes the adhesions between the capsula propria and the kidney are so great in places that small pieces of renal tissue are torn, giving rise to hemorrhage. This, however, can be easily controlled by hot water or peroxid of hydrogen.

After the operation, there is often a reaction, the temperature going up to 101° or 102° F., which generally drops to normal after the bowels have moved.

Occasionally stitch abscesses form, causing a slight rise of temperature. The suture is removed from the affected part, the wound washed out with peroxid and a wet dressing (bichlorid solution) applied. The temperature then drops and the wound heals uneventfully.

I have had but one case of deep-seated abscess. This was in a woman who was a bleeder. She bled continually from the wound for three days. The bleeding was in the nature of an oozing. It was treated by injections of peroxid of hydrogen and hot water. The wound was then packed. It later became infected, a perinephritic abscess formed, which was opened and drained and treated as a collection of pus elsewhere. The wound healed slowly with a firm attachment of the kidney to the abdominal wall. Another case developed a hematoma, which pressed upon the ascending colon and gave rise to symptoms of ileus. These disappeared, however, after morphin for the pain was given, followed by a purgative. For further information see chapter on Movable Kidney.

Renal Decapsulation.—I shall say only a few words regarding renal decapsulation, as I have considered it in the surgical treatment of chronic nephritis; but it is not a procedure to be recommended, as my experience has shown me that it is harmful, rather than beneficial.

The steps of freeing the kidney are the same as those described under nephropexy. The organ is decapsulated in the same manner, excepting that it is drawn back on either side to the hilum, after which the entire capsula propria is either cut away by scissors or else it is rolled up around the pedicle and left there. The decorticated kidney is then replaced in its fatty capsule, from which it is supposed to obtain an additional supply of blood through the extension of blood vessels from this capsule into the substance of the kidney. Results have shown that the blood supply received from the fatty capsule does not increase the circulation of the kidney and that a new capsula propria forms which compresses the organ much tighter than did the original one. The operation has now but few supporters either in this country or in Europe.

Nephrotomy.—The incision is through the convexity of the kidney into the pelvis. Nephrotomy is the operation *par excellence* in nephrolithiasis. It is also a valuable operation in hemorrhagic and neuralgic nephritis, and in all cases of suppurative kidney requiring drainage.

TECHNIQUE.—Before performing a nephrotomy on an organ that has been delivered, it is well to clean up quite thoroughly the ureter and the vascular pedicle, and to separate them from each other. I generally find the ureter first, as in the case of exploring the kidney, and then clean it with gauze up to the pedicle; after which, I pass my forefinger behind the vessels of the pedicle and free them from the surrounding tissues by wiping them with gauze.

The pedicle should be controlled while the incision through the parenchyma into the pelvis is being made. This can be done by an assistant hooking his

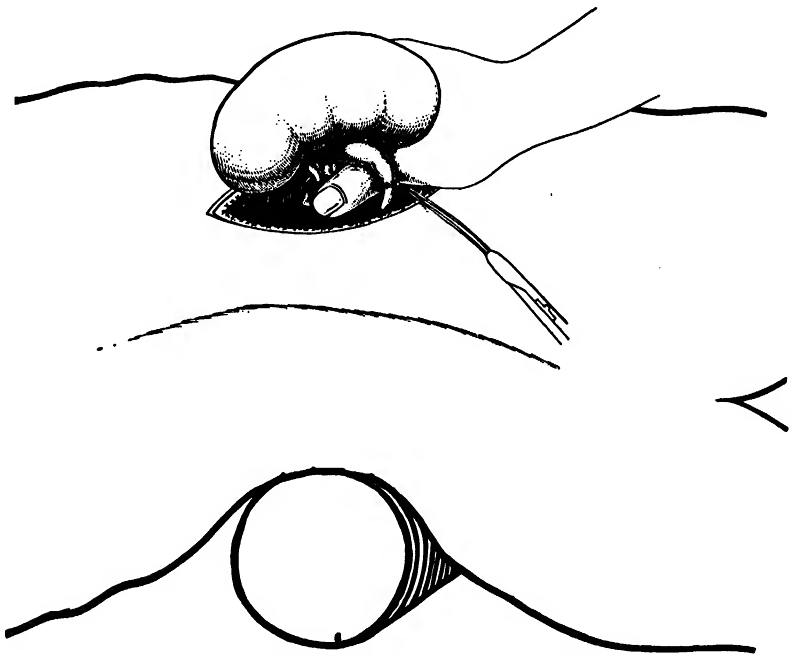


FIG. 354.—NEPHROTOMY. In performing nephrotomy the same position and loin incision is used. In all cases of nephrotomy the ureter is delivered and separated from the vascular pedicle, palpated, and has a traction suture placed about it. The vascular pedicle is then compressed by an assistant.

forefinger about the vessels and then flexing it tightly in case there is sufficient space; or if there is not, placing the tips of the fore and middle fingers on one side of the vessels of the pedicle and the thumb on the other and then compressing them (Fig. 354). I sometimes place a rubber band around the vessels and tighten it. A round band is the best, as a flat one is liable to cause traumatism. Having placed it about the pedicle, I am in the habit of grasping it with forceps and twisting it until the pressure is sufficient to cut off the blood supply. Clamps padded by rubber tubing can also be used, but I am always afraid of injuring the vessels by too much pressure.

After the blood supply has been shut off, the kidney is grasped at one pole between the thumb and forefinger of one hand, while the assistant, if desired, steadies the other pole in such a way that the organ is held in a straight posi-

tion. An incision is then made through the parenchyma into the pelvis. This should be made a little nearer the posterior portion of the convexity than the anterior, as then there is less danger of wounding the vessels. It can be a long

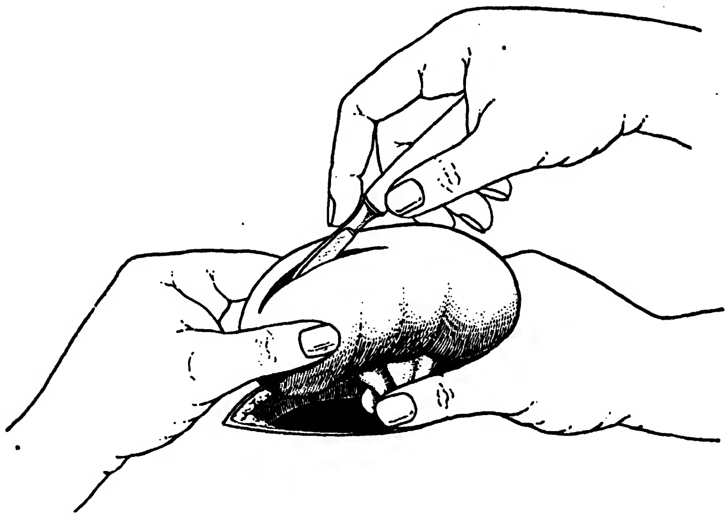


FIG. 355.—NEPHROTOMY; THE LONG INCISION FROM POLE TO POLE, A LITTLE NEARER THE POSTERIOR PORTION OF THE CONVEXITY THAN THE ANTERIOR. It gives a better view of the interior of the kidney and its pelvis.

incision from pole to pole (Fig. 355), or a short one between the poles (Fig. 356). In the former case, a better view of the interior of the kidney and its pelvis is given; whereas in the latter, it is only sufficiently large to palpate the interior, which would be necessary for the detection of a calculus or for the drainage of a pus kidney. The best rule for the short incision is to divide the convexity of the kidney into three parts transversely and then to make an incision $1\frac{1}{2}$ inches long, having its center at the junction of the lower and middle third of the organ. This incision should be 5 millimeters posterior to a vertical line drawn through the middle of the convexity. After the incision has been made down to the pelvis, the tip of the finger should be introduced into the pelvis and the calices, and, with the fingers of the other hand on the outside of the kidney and ureter, a very complete examination of the organ can be made. The ureter should then be catheterized from the renal pelvis down to the bladder to see if there is any impediment. Calculi can sometimes be detected by downward catheterization which had not been noticed when the ureter had been catheterized from below upward (Fig. 357).

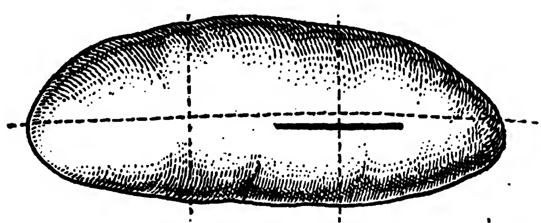


FIG. 356.—NEPHROTOMY; THE SHORT INCISION BETWEEN THE POLES. It is only sufficiently long for palpating the interior of the kidney and its pelvis or for drainage.

In case of a kidney with an apparently healthy parenchyma, it is advisable to cut through as little as possible of it, as the sutures that are employed to close it cause some traumatism in their passage; besides which, the pressure on the renal tissue required to hold the sides of the wound together tends to interfere with the circulation in the cortex. In any case, if it is necessary to thoroughly inspect the wound, an incision along the entire convexity should be made, although this would give rise to more hemorrhage. With the best conservative measures which we have at present for compression of the pedicle, there is al-

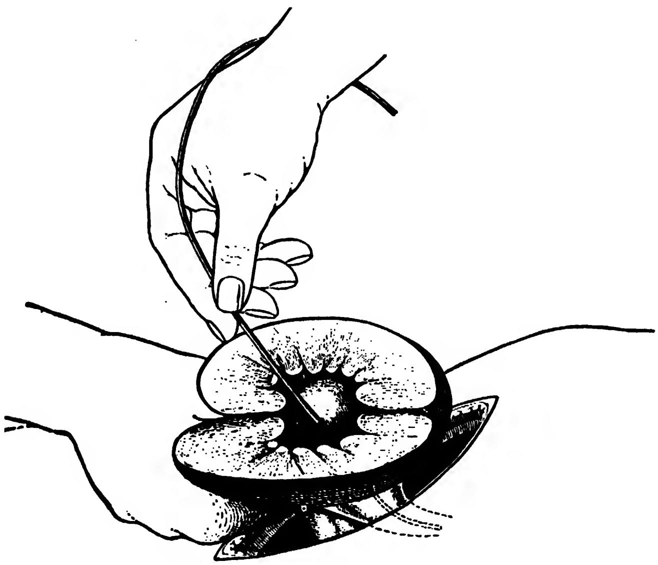


FIG. 357.—NEPHROTOMY; CATHETERIZATION OF THE URETER. The ureter should be catheterized from the renal pelvis to the bladder, to see if there is any impediment present.

ways some hemorrhage, and the first gush when the kidney empties itself may be sufficient to wash out a small stone as well as to disguise somewhat the character of the surface that we are inspecting. Sometimes we feel by the small incision an induration that resembles a stone and make the longer incision and find nothing but a node of fibrous tissue. The small incision is usually sufficient for examination and drainage.

TREATMENT OF THE RENAL INCISION.—This depends upon the causes for which nephrotomy is performed. When it has been performed simply for exploration, if nothing has been found, a specimen of the kidney tissue should be taken to examine for tumor or tuberculosis; if for the removal of stone, the calculus should be removed with a forceps; if for hemorrhagic nephritis, for an aseptic case of stone, for exploration, or in fact for any condition associated with an aseptic kidney, the renal incision can be closed immediately after the nephrotomy. In all suppurative cases, however, whether the operation has been performed for the drainage of a renal abscess or of a pyonephritic or pyo-

nephrotic kidney, a drainage tube—either a large single tube or two smaller ones —should be inserted through the renal incision into the pelvis, and should leave the kidney at the junction of its middle and the lower third, to remain as long as necessary for the individual case.

Suturing the Kidney.—In case the kidney is aseptic as well as the urine coming from it, the incision can be closed by interrupted sutures. I use sutures of chromic gut No. 2, which are passed through both sides of the incision $\frac{3}{4}$ of an inch apart and $1\frac{1}{4}$ inches from the margin of the wound, while between these, $\frac{1}{4}$ of an inch from the margin of the incision, another row of interrupted sutures No. 2 plain catgut is passed and ligated (Figs. 358 and 359).

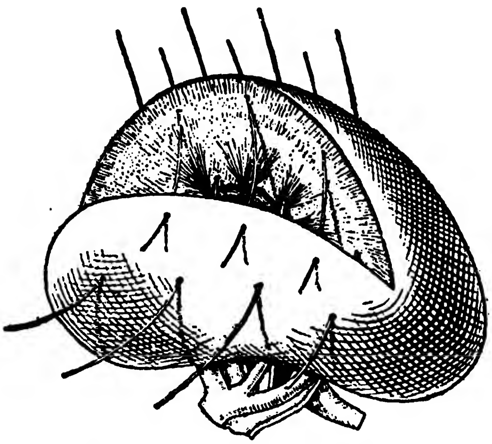


Fig. 358.—Method of Passing Sutures in Closing the Nephrotomy Incision in the Kidney.

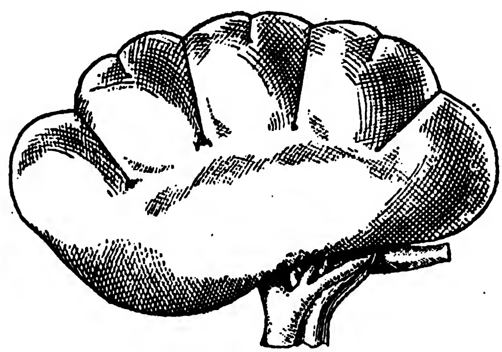
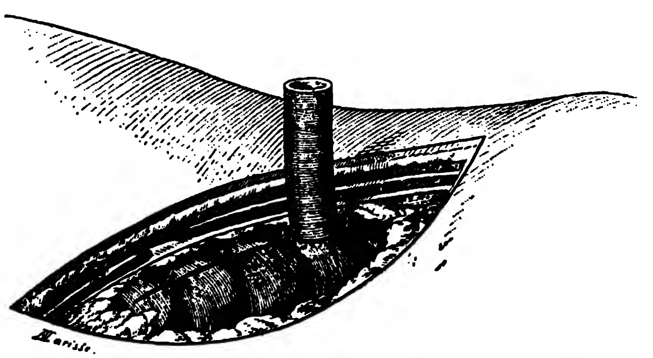


Fig. 359.—Appearance of the Kidney after Closure. Sutures should not be tied too tightly, as it injures the kidney.

A cigarette drain should then be introduced into the wound in the loin as far as the kidney and allowed to remain for twenty-four to forty-eight hours and as long after this as there is any evidence of urinary leakage.



'ig. 360.—Drainage Tube in Position. In pus cases a sc - rubber tube should be inserted into the renal pelvis and protrude at the junction of the lower and middle third.

If there is any pu found in the urine coming from the diseased organ, even if it is microscopical, a drainage tube, No. 25 French, soft rubber, should be inserted into the pelvis of the kidney at the junction of the middle and lower third of the organ. (See Fig. 360.) The kidney incision should then be closed up to the tube in the manner just described. It should then be drained for three or four days, and the kidney pelvis washed out with silver solution

1:1,000 at the morning dressing and with boric-acid solution at the evening dressing. In case extensive suppuration is seen at the operation, the kidney should be drained for eight days and washed out through the tube in the same way. It may even be wiser to drain every kidney, using a small catheter in cases in which there is no pus in the urine. In all cases, the tube should be attached to the kidney capsule by plain gut and a wick or cigarette drain should be passed by its side to the surface of the kidney. Cases without pus are, however, very rare in my practice.

Complications during and after Nephrotomy.—The complication that causes most alarm during nephrotomy is *hemorrhage.* This has often been very alarming in my own cases, especially in cutting into the kidneys of cases with hemorrhagic nephritis and anurias. If the vessels of the pedicle have been well grasped, the hemorrhage is controlled when the kidney is opened; but when the pressure is removed, it may become profuse. It is usually a capillary oozing, although sometimes there is a spurting artery. The oozing is generally controlled somewhat by hot water or peroxid of hydrogen. Adrenalin is sometimes used and has given better results in the hands of others than in my own cases. If very hot water, 120° to 130° F., is poured into the kidney and its two sides are immediately grasped and held together, the oozing will usually diminish so that the catheter drain can be inserted into the pelvis and the two sides fastened by sutures, as already described. If, after suturing the kidney, the bleeding continues and the operator feels worried about the case, I suggest that a four-tailed bandage be applied for a few hours. This measure has not been considered feasible heretofore, because the wound could not be closed as it should be after the operation on account of the necessity of withdrawing the bandage. An admirable device of Da Costa of cutting the base of the bandage in two and then sewing pieces together with plain catgut, which softens and allows the bandage to be easily pulled out, has greatly overcome this difficulty.

A four-tailed bandage consists of a piece of gauze 16 inches long and 8 inches wide, which is drawn under the kidney from above downward in such a way that *A* and *B* come above the pedicle, and *C* and *D* below it. Tails *B* and *C* are then tied together on the middle of the renal convexity and *A* over one pole and *D* over the other, thus controlling hemorrhage by pressure (Fig. 361).

A spurting artery is sometimes seen, especially when the long incision is made in the kidney from the extremity of one pole to that of the other and extending too far anteriorly in an uneven course. Such an artery should be caught and ligated. Often the ligature will not remain on; in which case, a ligature should be passed about it by a curved round needle and the artery, including the tissue about it usually on one side of the incision, should be ligated.

Sometimes the clamping and ligating of the artery is sufficient to stop the hemorrhage, and during the closing of the kidney the suture slips off and no

spurting follows. The question then comes up: Should the kidney sutures used in closing the kidney be removed and the artery be sought for and again clamped and ligated; should a clamp be left on, or a tailed bandage be applied? I generally do nothing but pack some gauze on either side of the kidney and close the wound up to the drain, in case one has been inserted into the organ, according to whether the case is aseptic or septic. I put on a light dressing and instruct the house surgeon to have the pulse taken every half hour and, in case it increases in rapidity and becomes weak, to notify me; if I cannot be found, to consider it as an emergency case, to give strychnin gr. $\frac{1}{30}$ by hypodermic and a pint of hot salt solution with 2 ounces of whisky by enema, to be retained. Then, in case the pulse does not rapidly improve, I instruct him to open the wound, withdraw the packing and deliver the kidney. In case the hemorrhage comes from the part of the spurting artery, I direct him to open that part of the kidney incision, clamp the artery and then either pass a ligature on a needle about it and ligate it; or clamp it and leave the clamp on for forty-eight hours; or put on a four-tailed bandage; or, if the hemorrhage is very bad and the patient's condition critical, put a clamp on the vascular pedicle. Then, except in the last instance, my instructions are to close the kidney again, pack gauze about it and return it to its fossa and bring the sides of the incision in the abdominal wall together by straps and notify me. On visiting the hospital, I would then, in the case of the buried ligature or the

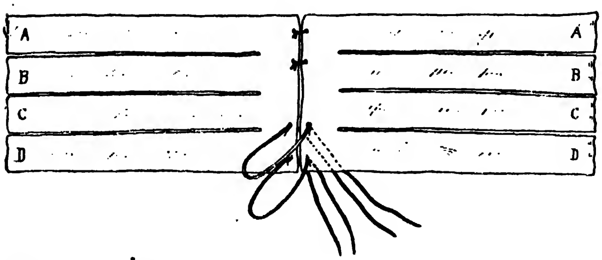


Fig. 361 A.—Four-tailed Bandage. The base of the bandage has been cut through and catgut sutures have been passed through the tails *A* and *B* and tied. Two others are passed through tails *C* and *D* and not tied. The looped parts of the two lower sutures are pulled out and slipped over the convexity of the kidney while the base of the bandage is being pulled by its concavity. After the bandage is in place the loose loops of the sutures are slipped over the lower pole of the organ and tied on the concave side like the two upper ones.

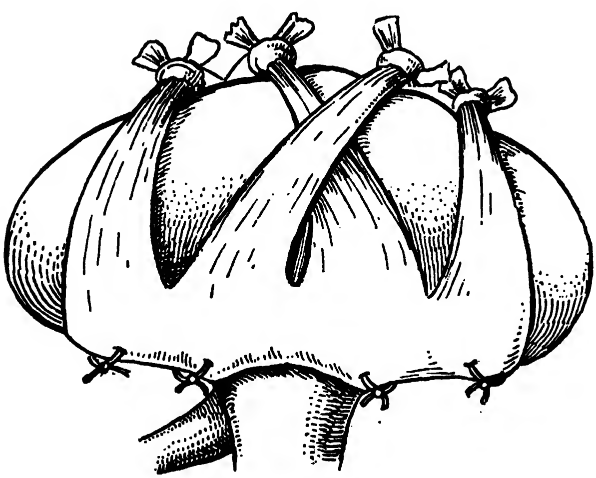


Fig. 361 B.—Four-tailed Bandage in Place. Tail *B* on one side is then tied to tail *C* on the other, as is also tail *C* to tail *D*; the tied ends crossing one another in the middle of the convexity. Tails *A* are then united over the upper pole and tails *D* over the lower.

clamp, probably simply close the abdominal wound, leaving sufficient space for the kidney drain or the clamp to protrude. In the third instance, I would inspect the kidney and withdraw the bandage or simply loosen it and leave it in place and watch the result, which would probably be favorable. In case of either the clamp on the artery or the bandage, it would not be left on over forty-eight hours. In the fourth instance, that is, when the renal pedicle had been clamped, I would do a nephrectomy.

I do not approve of packing the kidney and, in case it is done for hemorrhage, think that it should only be done for oozing and not for a spurting artery. In case the kidney is packed for hemorrhage, I think that a four-tailed bandage should be placed about the kidney and that it should be brought up to the opening in the abdominal wall and held there in a sling, thus making a temporary nephrostomy. I may here say that, although I have given the directions that I have just mentioned many times to a house surgeon and have been extremely anxious about many cases at the time of the operation, it has happened only once that a house surgeon has reported to me by telephone a case that I thought would have to be interfered with. In that particular case, he opened the wound in the loin, caught a spurting artery, stopped the hemorrhage by a buried ligature, and then closed the wound again. The case was one of hemorrhagic nephritis.

Urinary and pus sinuses are very frequent complications. A *urinary sinus* usually closes in from three to six weeks. In case it does not, a ureteral catheter can be passed up into the renal pelvis and retained there. If, on its withdrawal at the end of a week or two, the urinary discharge from the fistula has not decreased, then an exploratory operation should be performed to see if there is any cause for the interruption of the flow of urine down its natural channel. For the causes of such a condition, see the chapters on Urinary Retention in the Kidney, Hydronephrosis and Movable Kidney.

A *suppurative sinus* shows that a destructive process is still going on in the kidney which is probably the seat of a pyelo-nephritis or pyonephrosis. The sinus should be washed out with silver solution 1 : 1,000 and drained with the object of having it close from the bottom. In case, however, the sinus continues and the patient is losing weight and strength and running a slight temperature, an operation should be performed to see what the cause of the continued suppuration is and what the probabilities are of its cessation. This may be due to an unabsorbed suture, to a concealed stone or to a slow suppurative process from other causes. It usually means a secondary nephrectomy and it is not wise to allow the patient to continue too long without operation.

Poor Drainage.—After a nephrotomy in a septic case, the drainage often diminishes or ceases and later there is a rise of temperature and other symptoms of pus absorption. In such a case, a pocket of pus has formed, or the tube has been passed between some muscular layers or muscle and skin, instead of into

or down to the kidney. The forefinger should then be inserted into the wound, when it will soon strike a recent line of cleavage through which it will work its way down to the kidney and from there into any pocket that may happen to be present. In case the wound has closed and the finger cannot be worked down to a pus cavity, an incision should be made down to the perinephritic region and any pus pocket present should be drained.

In any case in which the patient's condition is impaired after a nephrotomy and in which a slow grade of sepsis exists, the condition of the two kidneys should be ascertained and, if the organ that has not been operated upon is healthy, the suppurating organ should be explored and any cause of suppuration encountered should be removed or corrected if possible; in case it is impossible, a nephrectomy should be performed.

Nephrostomy.—This means an incision through the convexity of the kidney into its pelvis, that is, nephrotomy, plus the stitching of its two sides to those of the incision in the loins. It is a good method in suppurative cases in which the kidney has to be packed; or when it is very much destroyed, as in some cases of calculous pyonephrosis; or when it is desirable to employ permanent renal drainage and consequently have it in the most convenient place for

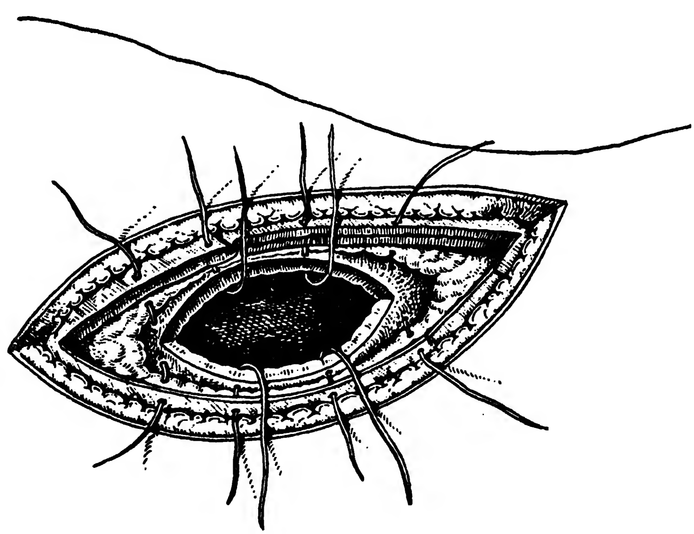


FIG. 362.—NEPHROSTOMY. This is nephrotomy plus fixation of the sides of the kidney incision to those of the abdominal wall. Note the approximation of the kidney wall to that of the abdomen.

inserting a tube. Before the kidney is incised, the fatty capsule should be dissected from it for about an inch on all sides of the area in which the incision is to be made so that the kidney will be in close apposition to the abdominal wall. The short or long incision can be made into the renal pelvis, after which it should be explored in the same way as in nephrotomy. Sutures should then be passed through the side of the abdominal wall and the walls of the kidney,

two on each side and one at each end, six in all (Fig. 362). These should then be pulled taut, which will bring the cavity of the kidney just behind the middle of the incision in the loin. The sutures should then be tied on either side

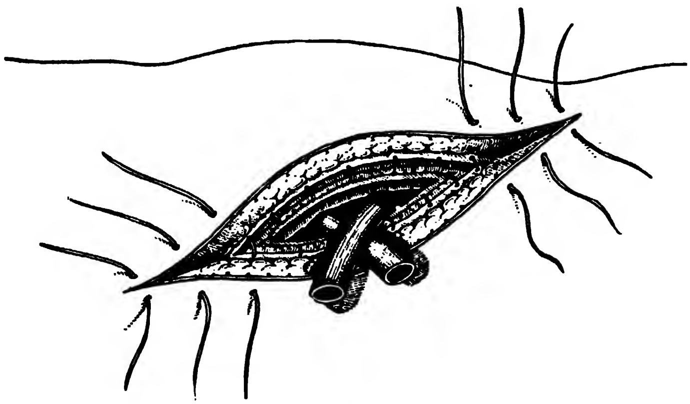


FIG. 363.—DRAINAGE IN NEPHROSTOMY.
This is practically the same as in nephrotomy. One or two tubes are used.

and the incision in the muscles and skin brought together by suture above and below up to the beginning of the incision into the kidney on either side. The kidney should then be packed with gauze. After the hemorrhage has ceased,

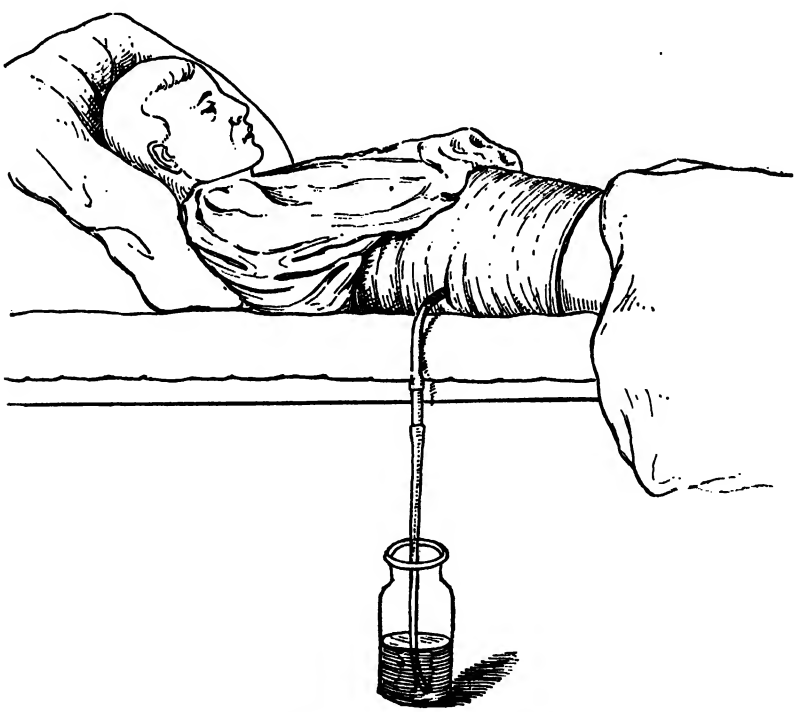


FIG. 364.—DRAINAGE BY SIPHONAGE.
Used after a nephrotomy or nephrostomy operation by bed patients.

the gauze should be removed and one or two tubes inserted for drainage (Fig. 363). The drainage tube, or one of them in case two are present, is connected by a glass tube with another piece of tubing extending into a bottle on the floor beside the bed (Fig. 364). The bottom of the bottle should be about one quarter full of carbolic-acid solution to facilitate drainage by siphonage. A binder should then be placed about the body, through which the tube protrudes.

The same methods of closing the abdominal wound, of inserting drainage tubes into the kidney and draining the wound by siphonage after operation are employed in both nephrotomy and nephrostomy.

Permanent Drainage after Nephrostomy.—This is occasionally employed when there is obstruction to the flow of urine through the ureter or into the bladder on one side. The apparatus devised by Watson, and recommended by him principally in nephrostomy for tumor of the bladder, is the preferable one.

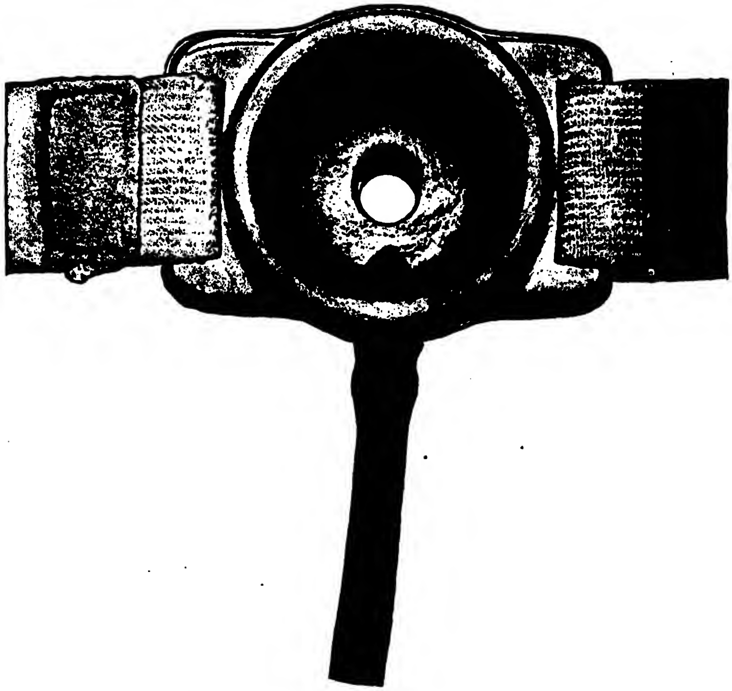


Fig. 365.—Cup-shaped Shield of Watson's Apparatus for Permanent Renal Drainage through the Loin. (After Ashton.)

Fig. 365 shows the front of the apparatus, which is bell-shaped, with a rubber ring about its base and a tube through its center. The front part of the tube extends into the kidney pelvis, whereas the outer end of the tube connects with a tin box hanging below it and resting on the back of the pelvis of the affected side. The urine runs through the tube into the tin box (Fig. 366).

Nephrectomy.—Nephrectomy is the operation for the removal of a kidney. It is a much more serious operation than nephrotomy on account of the necessity of cutting the renal pedicle, as this procedure may result in sudden death from extensive hemorrhage or in slow death from venous leakage after the operation. Death may also occur from shock in a few hours, or from anuria as the result of an acute congestion or inflammation of the other kidney, due to the amount of extra work suddenly thrown upon it.

Fig. 366.—The Metal Receptacle of Watson's Apparatus for Permanent Drainage of the Kidney after Nephrostomy. (After Ashton.)

This is the operation for every case of tumor of the kidney and of unilateral tuberculosis; also for cases of nephrolithiasis in which the organ is a mere pus sac. It should also be used in cases of ruptured kidney in which the organ is severely injured and incapable of functionating; or in case the hemorrhage is severe, in which latter instance it becomes an emergency operation.

Technique.—The freeing and delivery of the organ is the same as in the operations of nephrotomy. The consideration of the pedicle is most important and it is more essential in this operation than in any other to have the vessels well cleaned and free from fat, as it is then easier to pass the ligature and tie it with less danger of slipping, which is the important part of a nephrectomy.

The forefinger of one hand should be passed around the pedicle to steady it and the outside of the vessels should be wiped down with a piece of wet or dry gauze held in the other hand. In this way, an expanse of clean pedicle will be exposed, making it much easier to pass the ligature between the vessels without injuring the veins. A wide curved clamp with blades one and a half inches long should be placed on the pedicle in front of the ureter, this duct having been drawn back. The clamp should not be closed too tightly, as making too much pressure tends to increase the tension in the vessels of the pedicle, to bind them together more tightly and thus to make it more difficult to introduce the ligature carrier between the vessels without tearing them. The surgeon should

always remember, in placing the clamp about the vascular pedicle, to feel about it with the object of seeing that the ureter is not included, as this would tend to make the pedicle thicker and more difficult to ligate securely. I have, on a few occasions, caught the ureter with the clamp after having carefully separated it from the vessels. In fact, in beginning to perform nephrectomies, I frequently ligated the ureter and vessels together without ever having had a mishap. The ligature material used is generally chromic gut, but this is liable to slip, as the blood pressure in the renal artery is as great, if not greater, than any other artery in the body. Braided silk is the safer, although it tends to leave a sinus that may not heal for several months, but it is better to have a sinus remaining than death from operative hemorrhage.

There are numerous instruments used for carrying the ligature between the vessels of the pedicle. The curved ligature carrier is usually employed and

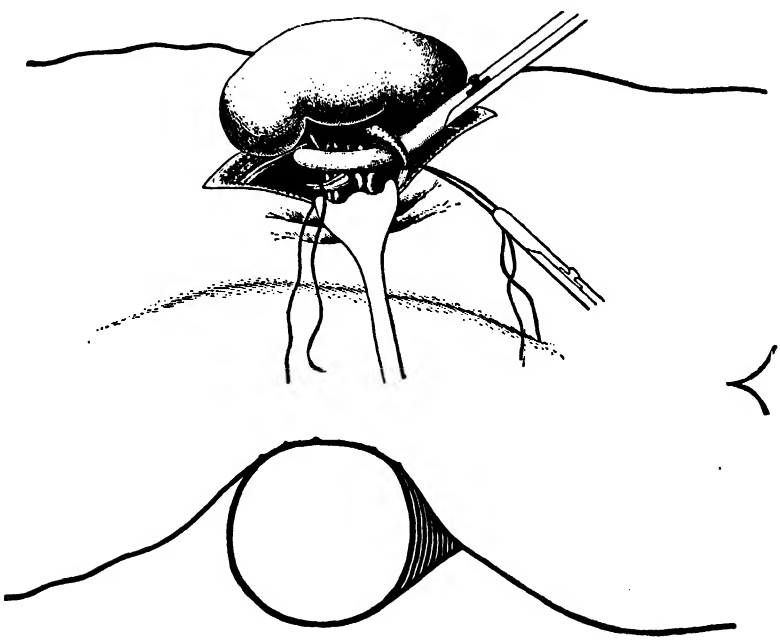


Fig. 367.—Method of Clamping the Pedicle and Passing the Pedicle Ligatures in Nephrectomy.

is pushed through behind a tight clamp. I have on two occasions torn the vein in this way and I prefer to pass a thin-bladed artery clamp gently between the vessels (Fig. 367). An assistant then inserts the ligature into its jaws on the other side, in such a way that I can pull it through double, cut it into two pieces and ligate the vessels on either side (Fig. 368). I have frequently used a pair of thumb forceps with equal satisfaction and also an aneurysm needle. It is often difficult for the assistant to thread the aneurysm needle if it is

passed unthreaded, whereas in case it is passed threaded, it is sometimes equally difficult to pick up the ligature on the other side.

If possible, there must be sufficient space left between the clamp and the kidney to cut through without injuring the organ or its pelvis. When I have considerable space, I put another clamp on the vessels above the first one and cut between the two after having ligated the vessels by means of a square or surgeon's knot. I leave the ends of the ligatures long.

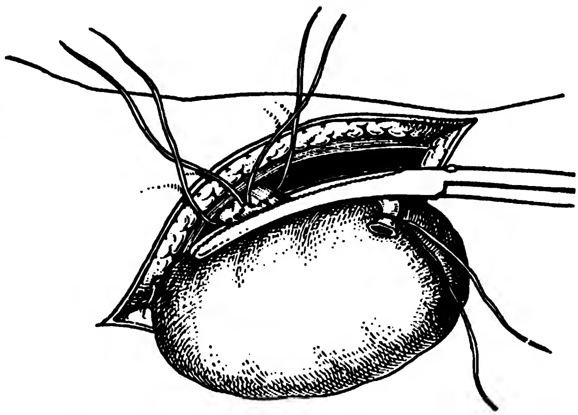
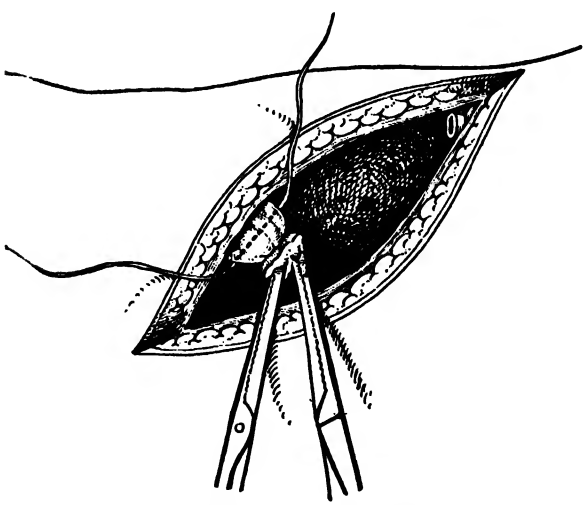


FIG. 368.—NEPHRECTOMY; LIGATURES IN PLACE READY TO TIE.

Immediately after the vascular pedicle has been cut through, if I have not already ligated and cut through the ureter, as I frequently do, I swing the kidney out of the incision until it hangs over the patient's back, attached to its ureter, while I inspect the ligated pedicle. I sometimes grasp the vascular ends of the pedicle with artery forceps and reinforce the double suture already tied by another nearer the spine (Fig. 369). The pedicle stump must be handled with great gentleness. Very frequently in the excitement of cutting away the kidney, the operator pushes a piece of gauze with force into the wound on account of some bleeding and in this way detaches the ligature, thus giving rise to more hemorrhage. It is, therefore, important to dry the wound with small pieces of wet gauze on a sponge holder and never to use a piece of dry gauze in this area. It is also advisable to make no traction on the pedicle ligatures, but simply to use them as guides to the stump of the pedicle. I nearly lost one patient through holding the pedicle ligatures while I turned for a pair of scissors. The body of the patient rolled over slightly, making traction on



IG. 369.—NEPHRECTOMY; SECOND LIGATURE. The kidne having been removed, it is often advisable to place second ligature above the first, provided the pedicle sufficiently strong.

the sutures, resulting in one slipping off and giving rise to a terrific hemorrhage. After cutting through the pedicle, the sides of the incision should be retracted and the stump of the pedicle gently sponged with a very small piece of moist gauze on a sponge holder.

Hemorrhage.—The treatment of bleeding is one of the most trying complications that a surgeon has to encounter. It is usually due to the wounding of a vein during the passing of the ligature. If a bleeding point is present, it can usually be seen and grasped with a pair of fine curved forceps and ligated with catgut without difficulty. Another cause of trouble in ligating a pedicle, is through placing a second ligature over the original one, which may loosen the first one and render both ligatures less effective. Any slight oozing can be controlled by packing gauze into the renal fossa. If there is a profuse hemorrhage, then a hot wet gauze pad must be immediately pushed into the wound and taken out quickly and the bleeding point sought for, clamped and ligated. In case, however, a large amount of blood suddenly wells up into the operative field, the operator must thrust the forefinger and middle finger of one hand into the wound with their backs downward in an endeavor to catch the stump of the pedicle between them and to pass a curved hysterectomy forceps beneath them with the object of grasping the bleeding vessels and stopping the hemorrhage and saving the patient's life, even at the risk of grasping peritoneum, duodenum, colon or other tissues. After stopping the hemorrhage by this means, it is well to leave the clamp in place or else the same mishap may recur.

I think that most cases of hemorrhage of the pedicle are caused by the operator becoming excited and wiping the wound out with gauze sponges and clamping the pedicle at random, thus loosening knots that would otherwise have held sufficiently well. The clamps just referred to should be left on the pedicle for four days, although in a number of instances two days have proved to be sufficiently long. The handles protrude from the wound and should be protected by gauze pads and a thick wreath of cotton. The position in bed of the patient who has clamps on the renal pedicle is lying on the healthy side. The wrist of the arm corresponding to the side operated upon should be tied to the side of the bed which the patient faces, while the ankle of the operated side is tied to the other side of the bed, to prevent the patient from rolling over on the back while asleep.

I may here say that nephrectomy, owing in some cases to the shortness of the vascular pedicle, to the diminished ileo-costal space, to a large amount of fat, or to other causes, may be considered the most dangerous operation in surgery. I have seen more surgeons become excited during this operation than in any other, and personally I have never felt so helpless as when, owing to the slipping of a ligature, I have had such a large amount of blood suddenly well up into the wound that I expected the patient to die immediately; but up to the present writing, no death from hemorrhage has occurred.

Treatment of the Ureter.—The next step in our nephrectomy operation is cutting through the ureter to which the kidney is hanging over the side of the body, in the cases in which it was not cut before the pedicle was cut through. It should in this instance be ligated in two places, leaving a space of half an inch between the two ligatures, and then cut through. In case the organ is infected, the remaining end should be cauterized with carbolic or with the Paquelin and then fastened into the wound. If it is tuberculous, the same treatment can be used. In case it is extensively diseased, as much as possible of it may be removed, although I rarely have to resort to this procedure. After nephrectomy in a septic case or one of tuberculosis of the kidney, the wound should be washed out with a 1 : 2,000 solution of bichlorid of mercury or peroxid of hydrogen. It is prudent to leave a cigarette drain down to the pedicle for twenty-four hours and, on removing it, to insert a small catheter through the opening and again wash the wound out.

Accidents.—Accidents other than hemorrhage from the pedicle in performing nephrectomy are opening the peritoneum or the pleura; hemorrhage from an accessory artery; or the tearing of the vena cava.

Wounding the Peritoneum.- This is usually torn through accidentally in freeing the kidney that is very adherent to the surrounding tissues. In this case, the surgeon may see through the tear the smooth peritoneal surface, the omentum or intestine, or one of the organs, as the liver or spleen.

In aseptic cases, sponge any protruding part with salt solution, replace it and close the peritoneum with plain catgut sutures. In septic cases, the protruding part should be washed with peroxid of hydrogen and later with salt solution, before returning it and suturing the rent. On one occasion when the tear was small and nothing was protruding, I simply placed a piece of gauze over the tear to wall it off from the operation field and allowed it to remain in place for two days after the operation. I have never had any trouble result from opening the peritoneum, although in one septic case I could see the lower part of the lobe of the liver protruding.

Opening of the Pleura.—The pleural cavity is usually opened when cutting up to the twelfth rib with scissors in the effort to make the incision as high as possible. The accident is immediately recognized by a peculiar, rough, aspirant sound, caused by the sucking of air into the pleural cavity and its discharge during the acts of inspiration and expiration. I can remember at the present writing only a single instance in which I cut through the pleura in nephrectomy, although I also did it in a case of hydatid cyst of the kidney, in which the cyst alone was operated, and in a case of movable kidney. In these cases, I simply closed the opening by a continuous suture of chromic gut and do not think that the accident had any bearing on the result of the operation.

Hemorrhage from an Accessory Artery.—Hemorrhage, as I have already mentioned, is the most trying and dangerous accident that can occur in nephrec-

tomy. It sometimes comes from accessory arteries. These usually enter the kidney on its internal border at the upper or lower pole. These vessels are usually torn through and bleed while the surgeon is separating the fatty capsule from the kidney. The bleeding point is caught by artery forceps and ligated. If difficulty is found in stopping the hemorrhage with the ligature, the latter should be passed threaded on a needle and the artery ligated together with the fatty tissue through or along which it passes. In case this is not sufficient, the vessel should be clamped and the clamp left on for a day or two.

Hemorrhage from the Vena Cava.—Hemorrhage from a tear in the vena cava occurs very rarely and usually in the case of malignant growths of the kidney with adhesions, although it may also take place in the case of suppurative diseases, as in pyonephrosis. The methods used to stop the hemorrhage in this accident have been tamponing; placing forceps on the part torn; suturing the vena cava; ligating the torn area by a lateral ligature; and finally completely ligating it. Strange as it may seem, the ligature of the entire vena cava below the renal arteries has been employed a number of times and seems to have given the best results, the return circulation taking place through the azygos and vertebral veins. Gosset and Lecène (*Tribune medicale,* 1904) have shown by their experiment on dogs that, when the vena cava is ligated below the renal veins, the dog stands a fair chance of recovering; but when it is ligated above them, serious kidney lesions take place and the result is fatal.

Complications after Nephrectomy.—The complications that occur after nephrectomy are: Anuria, infection, urinary or purulent fistulas, fecal fistulas. *Hemorrhage* occurs sometimes after the operation, but rarely to a degree sufficient to require more than to remove the suture in the abdominal wall and tampon the renal fossa.

Anuria.—I am led to believe that this is extremely rare and will not occur if we assure ourselves before the nephrectomy that the other kidney has sufficient eliminating power to carry on the renal function after the operation. As I look back over the nephrectomies that I have performed during the last seventeen years, without making careful statistics I can only recall three cases dying from anuria after nephrectomy, all of which cases occurred before we were skilled in ureteral catheterization and in estimating the renal function of each kidney. One of these was a case of tuberculosis of a unilateral kidney operated upon without sufficient study or observation, another was a case of nephrolithiasis associated with pyonephrosis and the third was a case of multiple abscess of the kidney—an emergency case. The case of unilateral kidney died eight days after the operation; the second case three days afterwards, the autopsy showing acute cloudy swelling of the remaining kidney; the third, two days after, no autopsy.

Anuria should be treated medically after nephrectomy. We should give salt solution (normal) by hypodermoclysis—8 ounces every four hours if the

patient has lost much blood—as well as a high cleansing enema of salt solution. Cups over the kidneys are also helpful. Internally, from 5 to 10 grains of diuretin should be given every three hours in capsule, or theocin gr. j every hour.

If anuria persists for three days after a nephrectomy, a nephrostomy should be performed on the remaining kidney and injections of salt solution by hypodermoclysis and by rectum continued. The first danger signals of uremia in these cases are generally headache, twitchings during sleep and contractions of the pupils.

Infection of the Wound.—A rise of temperature to 100° or 102° F. is the usual operative reaction and does not mean any more than it would after any other kidney operation. It lasts from a few days to a week, although the temperature usually goes down or to normal after the bowels have moved. In case it does not, however, it would be advisable to examine the wound. If it is due to a stitch abscess, the surgeon should take out the stitches. If due to gauze having been left in the wound, it should be removed, the wound washed with peroxid of hydrogen or a 1 : 2,000 solution of bichlorid and a wet dressing of bichlorid applied locally.

Frequently after operations on suppurative kidneys, a *purulent discharge* continues from the operative field. In these cases, the temperature may suddenly go up and it will be noticed that the drainage has stopped or diminished as after a nephrotomy operation. The forefinger is then introduced into the wound and works its way down into the renal fossa and finds the accumulation of pus. It should then be washed out with peroxid solution and a drain inserted and the wound allowed to close from the bottom up. After nephrectomy for tuberculosis, the fever may be due to a tuberculosis of the tissues in the renal fossa requiring antiseptic irrigations and drainage.

Shock.—Avoid shock by hastening the operation. Determine beforehand just what operative procedure will have to be done, just what may happen and what to do in case it does happen. Have everything in readiness. Begin as soon as the patient is under the anesthetic and stop the anesthesia as soon as possible. Give the patient $\frac{1}{30}$ of a grain of strychnin before leaving the table and a pint of salt solution with 2 ounces of whisky by enema after he is in bed; then alternate the strychnin and the hot saline enemas every four hours until the danger of shock has passed and the patient's pulse is good.

Suppurating sinuses are due to silk ligatures, fungosities and abscess cavities above or below the pedicle. In tuberculous cases, the walls of the wound may be lined with granulations or tubercles.

When silk ligatures are used, the ends should remain long and protrude from the wound and they can then be twisted off. In any case, however, the ligatures usually come away within three months and the sinus heals. In the case of abscess pockets, they should be opened, washed out with a solution of bichlorid, nitrate of silver, or peroxid of hydrogen, singly or alternating.

In tuberculous cases, curette the sides of the wound and pack with iodoform gauze. In all pus cases, good drainage must be kept up.

After a nephrectomy of any variety, if infection is present in the wound, a cigarette drain or tube should be passed down to the kidney stump and should be attached to the skin. The skin is closed by interrupted sutures.

Secondary Nephrectomy.—This operation is performed in two classes of cases: In the first instance, after a nephrotomy, performed for the object of drainage, tuberculosis or any suppurative condition of the kidney, or for stone; in the second instance, when one kidney is so diseased that a nephrectomy is called for, but the condition of the other organ is not sufficiently good to carry on the work of renal elimination. In this second instance, the diseased kidney is opened and nephrotomy done for the sake of drainage and with the expectation of removing the nephrotomized kidney as soon as the healthier kidney is able to do the work of total renal elimination.

The arguments in favor of and against secondary nephrectomies are considered in the various chapters of renal diseases. It is never used in tumor, sometimes in tuberculosis and suppurative diseases from other causes; but in my own experience, it has been most frequently employed in renal calculi.

The technique of secondary nephrectomy is the same as that of primary.

Subcapsular Nephrectomy.— This operation is indicated when the capsula propria and the fatty capsule are so adherent that they cannot be separated.

The united capsules should be cut through and peeled from the kidney on either side as far over the pedicle as possible. It is difficult to deliver the kidney because the pedicle is so short and encumbered. A clamp should be placed on the pedicle and a heavy braided silk ligature placed at the point to which the capsules have been peeled back; the vessels of the pedicle are cut through between the clamp and the kidney, after which the clamp is removed, although it can be left on for two or three days in case hemorrhage is feared.

Another method is to free the ureter immediately after decapsulating the organ, then to dissect up along the ureter to the renal pelvis, cut away as much as possible of the anterior and posterior parts of the united capsules and search for the vessels in the mass of adherent fat and fibrous tissue in front of the pelvis. After the vessels have been found, they should be freed by the method already described. Renal exploration and delivery of the kidney should then be attempted, although it is never very satisfactory. The pedicle can be clamped proximal or distal to the reflected capsules, depending on our success in freeing the pedicle. In either case, a braided silk ligature should be placed on the pedicle, after which it should be cut through between clamp and pelvis. The clamp should be left on or removed. Sometimes in subcapsular nephrectomies, the renal pelvis, ureter and vessels are all caught in one ligature, in which case there is liable to be considerable hemorrhage on cutting through the mass, as it is so large that it is difficult to secure it firmly.

Albarran strips off the united capsules, inserts the fingers of one hand under the upper pole and those of the other hand under the lower pole and, by pulling the organ down and toward the front of the body, he can usually bring the kidney into such a position as to be able to seize the pedicle by a clamp pushed from below upward. In many cases, he finds it impossible to see what is being done and is guided more by the sense of touch in placing the clamp on the pedicle before the decorticated kidney has been delivered. The kidney is then cut through above the clamp.

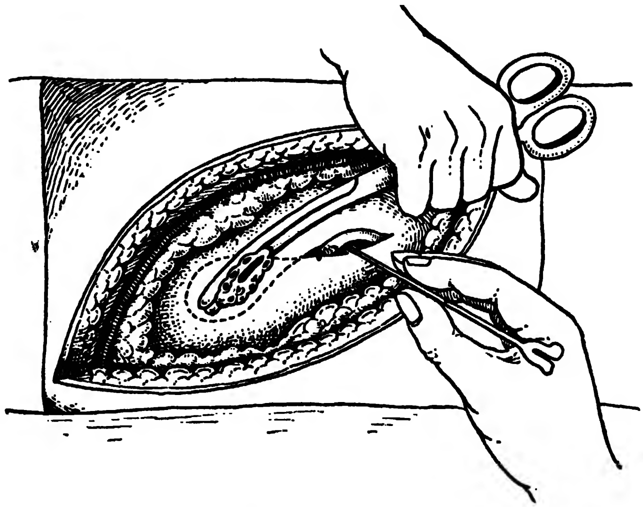


Fig. 370.—Albarran's Method of Securing the Pedicle in a Subcapsular Nephrectomy.

The stump of the pedicle, the ureter and pelvis remain in the clamp. The capsule is then cut through below the stump of the pedicle and the ureter found and followed up to the vessels of the pedicle and the capsule around the pedicle is then cut through (Fig. 370). This allows the capsule to slip back over the renal vessels toward the aorta and vena cava, thus making room for passing the ligature more carefully about the renal vessels behind the clamp. The ureter is then ligated separately and cut through, and the vessels of the pedicle as well (Fig. 371). The end of the stump of the pedicle containing the remains of the pelvis should then be removed, after which as much of the capsules as possible should be cut away with scissors, care being taken not to attempt to remove too much in case of firm adhesions.

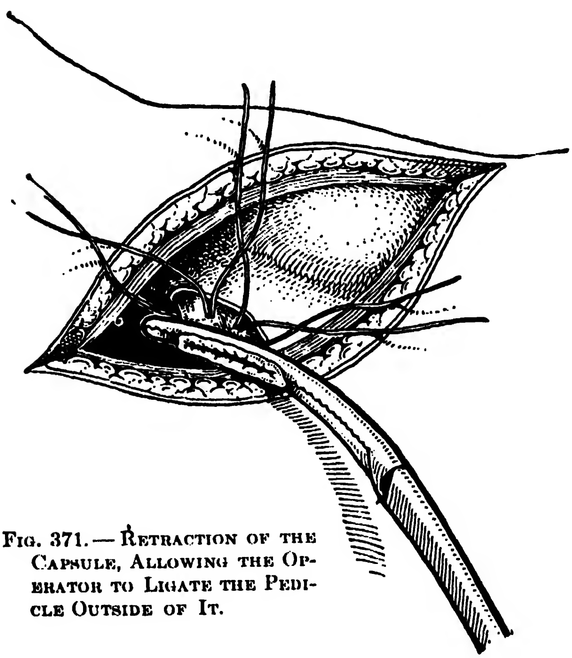


Fig. 371.—Retraction of the Capsule, Allowing the Operator to Ligate the Pedicle Outside of It.

In doing subcapsular nephrectomies in a mass of adherent fibrous and fatty capsules and tissues, it must always be remembered when the two capsules of the kidney are adherent and cannot be separated, that the ureter should be found and followed up to the renal pelvis, that the double capsule should then be pushed down to the pelvis and as much as possible of it removed with the scissors on all sides, thus giving more room for our work on the pedicle. A strong silk ligature can then be tied about the pedicle and adherent tissue as far from the kidney as possible. The kidney can then be split vertically. If, after it has emptied itself of blood, the bleeding discontinues, it shows that the ligature on the pedicle has shut off the blood supply. If the bleeding continues, another heavy ligature or a clamp can be applied until it ceases. After the bleeding has ceased, both sides of the kidney can be cut away with scissors.

Partial Nephrectomy.—This means the removal of part of the kidney. It is not a common operation and is usually confined to one pole of the kidney. It is indicated in the case of an injury or malignant growth. This is also an exceedingly difficult operation, as the blood vessels on the sides of the kidney are quite large and bleed so freely that they are difficult to control; besides which it is not easy to secure a good apposition and firm union of the cut surfaces.

The organ having been delivered, it should be carefully held and the pedicle firmly compressed. A wedge-shaped piece should then be excised from the portion of the organ involved, after which its edges are drawn together with sutures of No. 2 chromic catgut, which should be inserted $1\frac{1}{2}$ cm. from the border of the incision, passing through the deepest part of the renal tissue, 15 mm. from one another, before the pedicle is relieved of compression (Fig. 372).

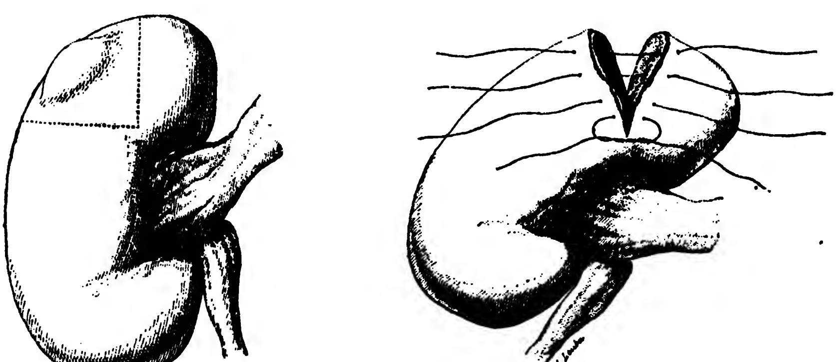


FIG. 372.—PARTIAL NEPHRECTOMY. Illustrating the manner of excising a portion of the kidney and uniting the sides of the gap that is left. (After Albarran.)

Nephrectomy by Morcellement.—This operation was made popular by Pean when renal surgery was in its infancy and is now rarely performed. It is well, however, for a surgeon operating on the kidney to be familiar with all the methods, as he might find himself in a very uncomfortable position in attempting to

do the regular nephrectomy operation in a case in which the subcapsular nephrectomy or morcellement was indicated. It should be employed in rare instances, when subcapsular nephrectomy is impossible on account of a perinephritic inflammation with adhesions of the fibrous and fatty capsule to each other and to the surrounding tissues, as the freeing of the kidney in these cases is liable to produce serious hemorrhage.

TECHNIQUE. — When the fibrous and fatty capsule cannot be sufficiently freed from the organ to place a clamp on the pedicle, the kidney should be decapsulated by cutting

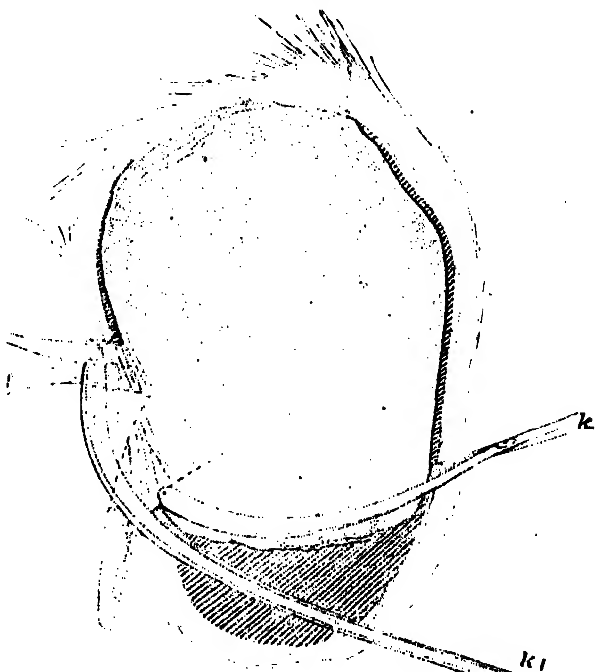


FIG. 373 A. — NEPHRECTOMY BY MORCELLEMENT. The lower pole amputated below a straight clamp *K*, passed transversely across the kidney at the junction of the lower pole and middle part of the organ, and a curved clamp (*K1*) passed below it, compressing the vascular pedicle. (Tuffier.)

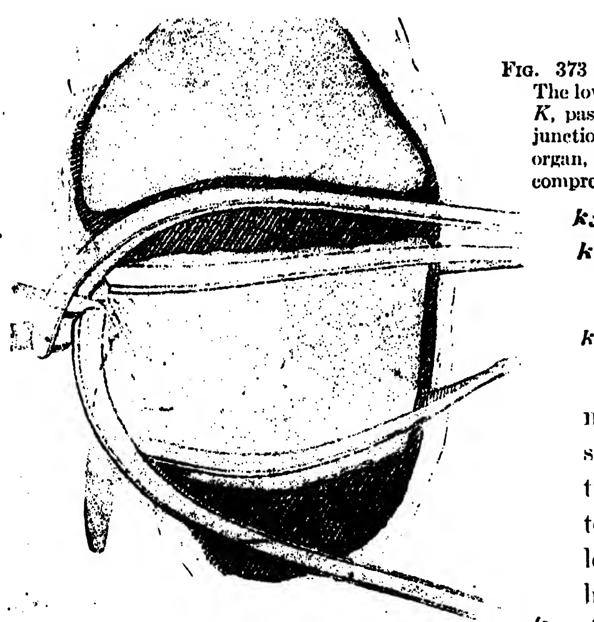


FIG. 373 B.—NEPHRECTOMY BY MORCELLEMENT. The upper pole amputated, and corresponding clamps *K2* and *K3* *in situ*. (Tuffier.)

through the combined capsules of the kidney over the convexity by a vertical incision and pushing them back on either side. The lower pole of the kidney should be freed and a pair of strong straight forceps applied transversely with a sufficient force to shut off the circulation in the lower pole. This pole should then be cut away below the clamp. A curved clamp should then be passed beside the detached part of the kidney, and should grasp as much as possible of the pedicle. The upper pole should then be freed as well as possible, and a straight clamp applied transversely to the kidney tissue in

such a way as to shut off the blood supply to the upper pole. The upper pole should then be cut away above the clamp, and another curved forceps should be passed by the remaining stump of the upper pole and should grasp as much as possible of the pedicle. By these maneuvers the blood supply has been shut off from the kidney by the two curved clamps on the pedicle and nothing remains of the organ but an area of kidney tissue corresponding to the space between the poles. This can be removed piecemeal or in one piece after detaching the straight clamps. A ligature should then be thrown about the pedicle beyond the clamps and ligated. In case this cannot be done, then the clamps should be left on from two to four days.

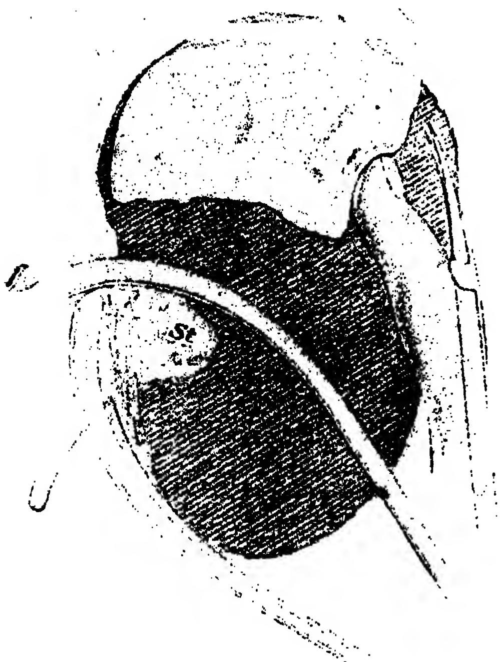


Fig. 373 C.—Nephrectomy by Morcellement. *St* shows the remains of the isthmus between the two poles after it has been cut down. (Tuffier.)

Closing the Wound.—In all the operations that have thus far been described, the curved incision in the lumbar region with the patient lying on the healthy loin has been employed. The wound is closed with No. 3 chromic gut, interrupted sutures passed, first, through the deep lumbar fascia; second, through the muscles and third, through the superficial fascia and skin.

The drainage tube, if one is employed, as is generally the case, is inserted just below the twelfth rib at the apex of the kidney angle down to the stump of the renal pedicle. It should be fastened to the skin with plain catgut on closing the wound.

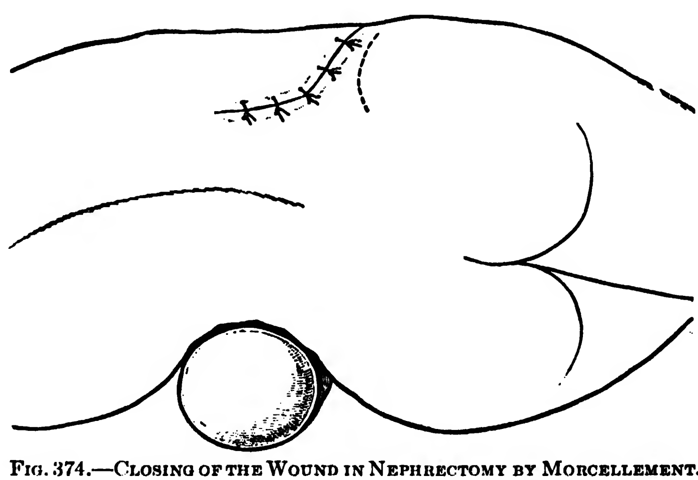


Fig. 374.—Closing of the Wound in Nephrectomy by Morcellement. The muscular and fascia layers of the wound are closed with interrupted sutures of No. 3 chromic gut; the skin also by interrupted sutures.

Nephrectomy by the Transverse Incision.—This is made in a transverse line at the level of the umbilicus from the erector spinæ muscle to the rectus abdominis (Fig. 327). The patient can be placed on the healthy side or on the back; the latter position is preferable and will be considered here. It is well to have a log or sand bag beneath the patient in such a position as to stretch the ileo-lumbar space as much as possible. The incision is popular in cases in which it is desired to ligate the pedicle before freeing the organ, although it can be applied whenever a nephrectomy is to be performed, as in tuberculosis or tumor of the kidney. It is not such a good incision for nephrotomy, nephrostomy or an exploratory operation and is never used in nephropexy. It is quite frequently followed by hernia.

FIG. 375.—NEPHRECTOMY BY THE TRANSVERSE INCISION. The kidney delivered, the muscular wall having been cut through and the peritoneum pulled toward the median line.

The technique is simple. The incision is made through the skin and muscular wall of the abdomen and its fasciæ down to the peritoneum. The operator then stands on the healthy side of the patient while the assistants retract the wound and he gradually works his hand with his finger tips curved in the direction of the interior abdominal wall and gently separates the peritoneum from the internal fascia, at the same time drawing it with its contents toward the median line until the fatty capsule is seen.

An assistant then holds back the peritoneum and its contents toward the healthy side and the surgeon cuts through the fatty capsule, showing the kidney. The organ, ureter and pedicle are then exposed and freed, and the peritoneum with its contents within is drawn still further toward the healthy side and the kidney is delivered (Fig. 375). The vascular pedicle is then clamped and

ligated by the same method as has already been outlined (Fig. 376), the kidney removed and the ureter ligated and cut through. The different layers of the abdominal wall are closed layer by layer in the same way as after the other lumbar incisions.

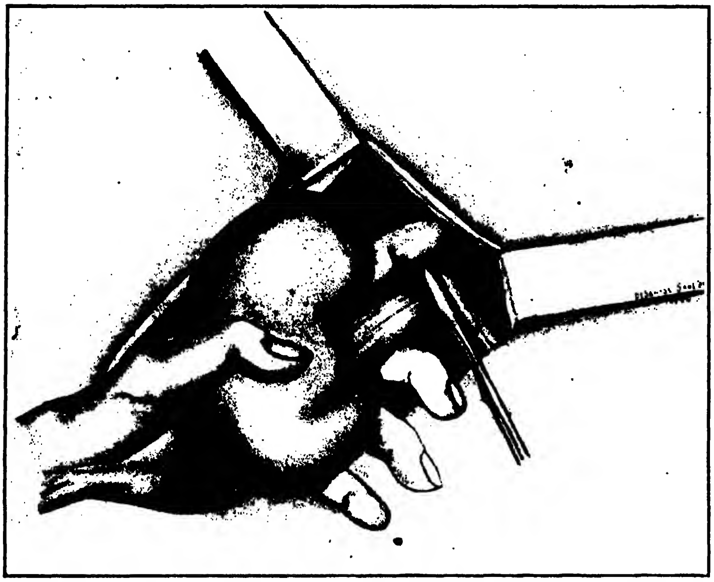


FIG. 376.—NEPHRECTOMY BY THE TRANSVERSE INCISION. The vascular pedicle clamped after the ureter has been pulled to one side.

Anterior or Transperitoneal Nephrectomy.—This operation is generally performed in cases of tumor of the kidney, especially in children, in cysts of the organ and hydronephrosis, as it is supposed to give more space. The patient is placed in the dorsal position, with something under the back as already described in the preceding operation. A vertical incision is made, extending down along the outer border of the rectus abdominis muscle, through the skin, muscular wall and peritoneum (Fig. 326). The intestines and colon over the kidney are drawn toward the healthy side; the wound is widely retracted and the intestines are well walled off with abdominal pads. This gives a good view of the outer layer of the mesocolon through which the incison is made without hemorrhage, as the blood vessels going to the colon are in the inner layer of the mesocolon. The cut along the outer border of the colon is about an inch from it and is continued for a sufficient distance to deliver the kidney (Fig. 377).

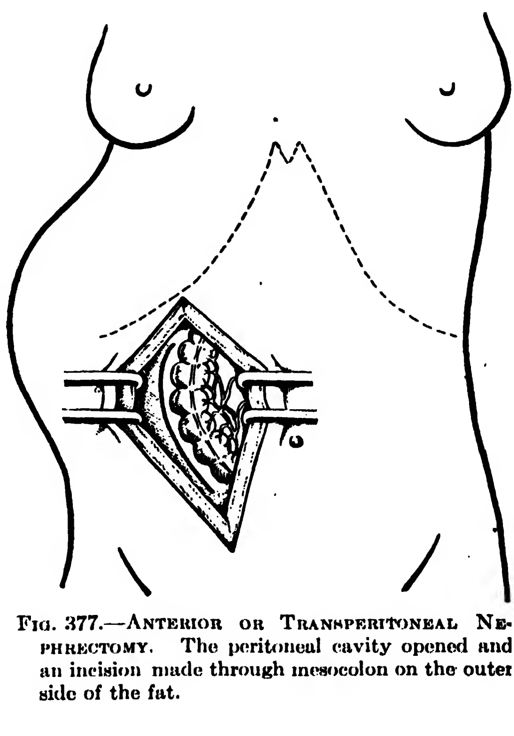


FIG. 377.—ANTERIOR OR TRANSPERITONEAL NEPHRECTOMY. The peritoneal cavity opened and an incision made through mesocolon on the outer side of the fat.

The fat about the kidney can easily be seen and, when cut through, shows the kidney. The fatty capsule is pushed away from the posterior surface of the organ and then from the anterior, care being taken in the latter case not to injure the blood vessels. The adhesions are sometimes very dense and have to be clamped and ligated as in doing extraperitoneal operations (Fig. 378). The kidney is then delivered and the pedicle is clamped, ligated and cut through, and the kidney is removed in the same manner as in the transverse incision (Fig. 379). By increasing the incision downward, the lymphatic glands can be seen and removed in malignant cases. The peritoneum is then closed with No. 2 plain catgut posteriorly and anteriorly, the fascia and the muscular wall are closed with No. 3 chromic gut and the skin with plain gut, chromic gut or silkworm gut as preferred. In case drainage is indicated, an incision should be made through the loin from within outward, just below the twelfth rib and along the quadratus lumborum muscle in the kidney triangle, and a drainage tube should be pushed through before closing the peritoneum posteriorly. After the operation, the dressing should be performed through the loin incision, as in the case of an operation through the loin.

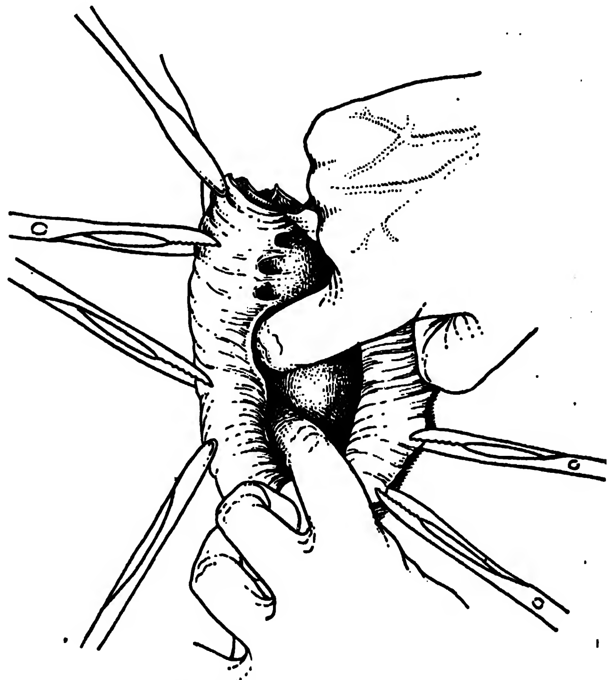


Fig. 378.—Anterior or Transperitoneal Nephrectomy. The kidney being freed from the fatty capsule after the posterior parietal peritoneum has been opened.

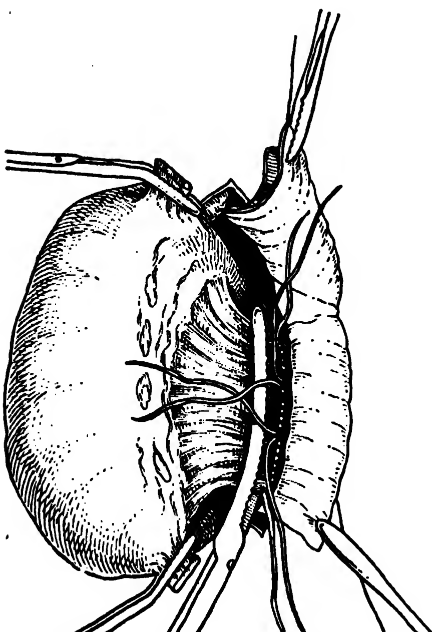


Fig. 379.—Anterior or Transperitoneal Nephrectomy. The kidney delivered; the pedicle clam[illegible]

In some patients it is considered desirable to drain from in front, in which case the internal anterior and posterior layers of peritoneum are sewed together as are the external anterior and posterior layers. This leaves a space down to the renal fossa through which a drainage tube is passed. The peritoneum, muscular wall and skin are then sutured individually up as far as the tube and a strip of gauze is inserted on either side of the tube (Fig. 380).

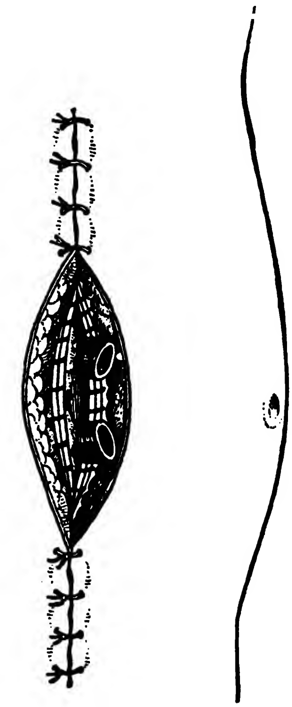


FIG. 380.—ANTERIOR OR TRANSPERITONEAL NEPHRECTOMY. The kidney removed, the wound closed, and the drainage in place.

Operations for Uronephrosis and Uropyonephrosis.—Uronephrosis (hydronephrosis) and uropyonephrosis are usually due to an improper relation between the pelvis and the ureter. They may also be due to nephroptosis and to numerous other causes, among which are abnormalities of the ureter.

The blood vessels may be irregular in their distribution and their relations to one another. Abnormal branches of arteries may exist, acting as strands (cords) on which the ureters double when a movable kidney fills with urine and falls over them. If such a branch is cut to afford relief to the kidney, necrosis might take place in the part of the organ supplied by the branch. Small vessels going to adhesions can safely be cut.

In hydronephrosis, the small pockets are first a part of the pelvic cavity; later the kidney tissue becomes atrophied, and large pockets form. These enlargements usually take place first in the lower part of the renal pelvis, then in the central and upper portions, corresponding to the two principal divisions of the pelvis, resulting in an enlargement of the pelvis as well as all the calices entering into it. At other times it is simply a bag in which but little kidney tissue is recognized. The amount of fluid in hydronephrosis varies from a few grams to a few liters (Fig. 381).

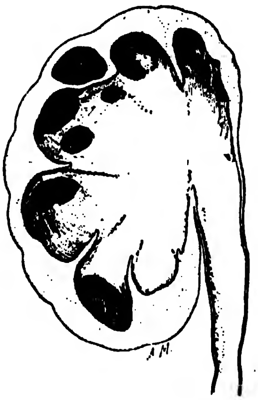


FIG. 381.—HYDRONEPHROSIS. It is apparent that the lower part of the dilated sac cannot drain through the ureter and that retention of urine takes place there.

OPERATIVE TREATMENT.—The variety of operation for uronephrosis depends upon (*a*) whether the ureter is of good size and permeable; or (*b*) strictured, or (*c*) impermeable.

(*a*) When the ureter is of good size and permeable, we must notice whether or not the ureteral orifice is normal and at the lowest point of the pelvic pouch and draining its cavity thoroughly; or whether it is placed too high and consequently makes a spur, damming back the urine. If it is not so placed as to drain the pelvis well, it is necessary to (1) do a nephropexy, (2) resect perhaps a portion of the pouch below the ureter, (3) perform a capittonage operation, and reef or tuck up the part of the sac below the ureter, or (4) in case the ureter is placed too high, cut down the spur.

(*b*) When the ureter is strictured at the level of its entrance into the pelvic pouch, (5) uretero-plastic operations should be performed and in case these do not appear feasible, (6) a lateral or (7) an end-to-end anastomosis between the pelvic pouch and ureter should be made.

(*c*) When the ureteral canal is obstructed, a lateral or end-to-end anastomosis should be made.

TECHNIQUE OF OPERATION.—The patient is in the same position as for a nephrotomy, that is, lying on the healthy side with the loin to be operated upon exposed. It is important to have an incision sufficiently long, as this makes it easier to work on the renal pelvis. Besides this, it is important always to pass a ureteral catheter from below up to the renal pelvis.

(1) *Nephropexy.*—For the technique of this operation see the chapter on Nephropexy. The replacing of the kidney in its normal position often overcomes the renal retention in cases of movable kidney and establishes a satisfactory emptying of the sac.

(2) *Resection of the Pouch (Operation of Albarran).*—The technique consists of passing a ureteral catheter, freeing the kidney from its external capsule, making an incision in the renal pocket and exploring the cavity. A clamp is then applied transversely across the kidney just below the ureter, and another a centimeter below it. The kidney is then cut through between the two. After this, the two sides of the kidney pocket are united by interrupted sutures just

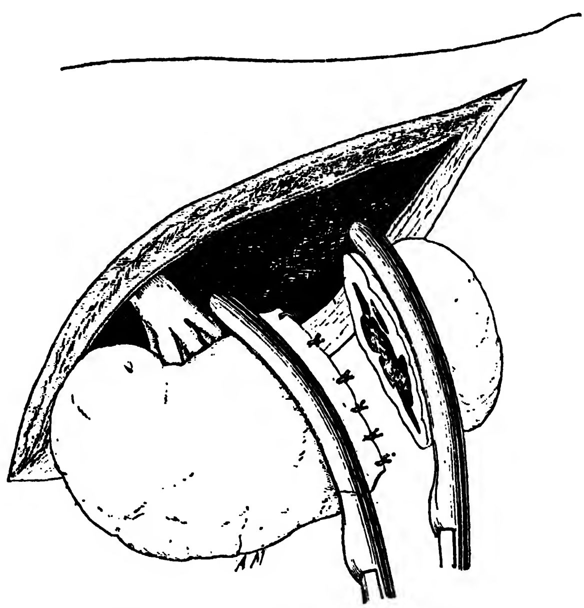


FIG. 382.—RESECTION OF KIDNEY POUCH BELOW THE URETER. Two clamps are placed across the kidney just below the ureter and the organ is cut through between them, after which the two sides of the remaining part of the kidney are united.

below the remaining clamp (Fig. 382). A ureteral catheter is passed through the ureter to be retained, and the wound closed, leaving in a lumbar drain down to the kidney. The kidney is then fastened to the abdominal wall by fixation sutures in such a way as to give good drainage to the organ and the wound up to the drain is closed.

(3) *Capittonage of or "Reefing" the Dilatation below the Ureteral Opening (Israel's Operation).*—The object is to bring the ureteral orifice to the lowest point, by drawing up the lower part of the pocket and straightening out the ureter. The sutures are so placed from below upward as to fold in the walls of the dilated pelvis by a series of tucks, in such a way as to give a straight course to the ureter. Lembert sutures are used, and four of them are passed through the posterior wall and then tied, thus straightening and narrowing the dilatation (Fig. 383).

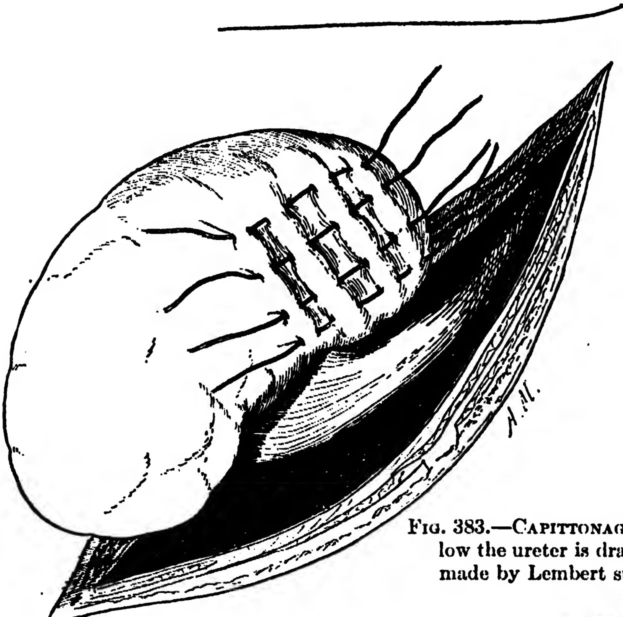


Fig. 383.—Capittonage. The part of kidney pouch below the ureter is drawn up by a series of tucks or reefs made by Lembert sutures.

In certain forms of dilatation of the pelvis, Albarran recommends making the tuck in the pelvis by transverse rather than by longitudinal sutures (Fig. 384).

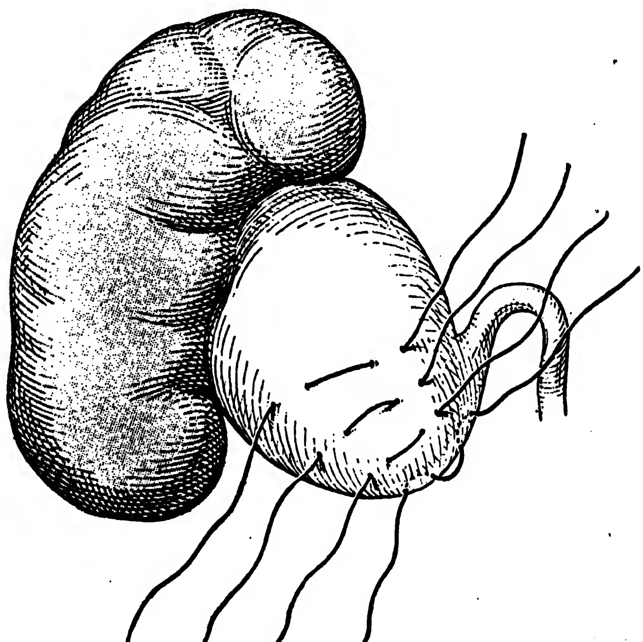


Fig. 384.—Albarran's Method of Suturing in Capittonage.

(4) *Cutting down the Ureteral Spur (Pyelo-ureteral Operation, Trendelenburg).*—The kidney pocket is cut through at a point opposite the ureter to its

lowest extremity and the adjoining wall of the ureter is cut down for the same distance. A long nephrotomy incision is made through the kidney

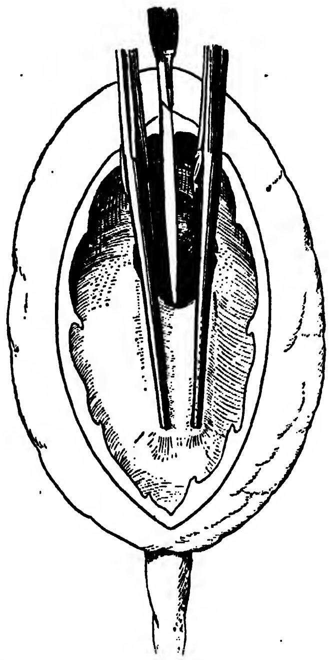


FIG. 385.—CUTTING DOWN THE URETERAL SPUR. After nephrotomy, two clamps are placed in such a way that each has one blade in the ureter and one in pelvis pouch. They are then clamped and the combined pelvic and ureteral wall is cut through.

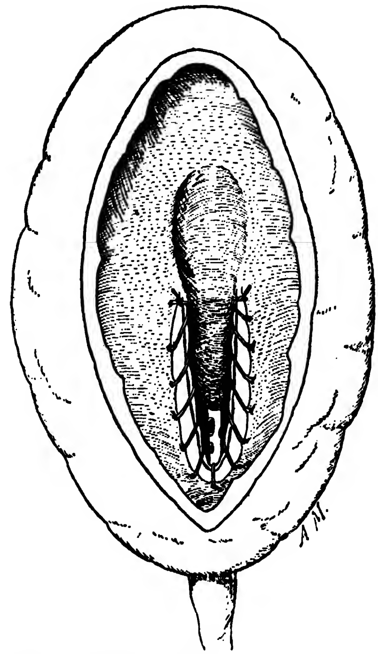


FIG. 386.—CUTTING DOWN THE URETERAL SPUR. Sutures passed uniting pelvic and ureteral walls on either side.

to the pelvis, which is opened widely to the bottom of the cavity. Two long-bladed (Kocher's) forceps are then introduced, each having one blade in the pelvis of the kidney and the other in the ureter. A ureteral catheter is passed down the ureter. A knife with a thin blade is then used to cut down the spur to the lowest part of the pelvic pocket (Fig. 385). The walls of the ureter and pelvis are then united by a continuous suture on both sides (Fig. 386). The ureteral catheter is retained. The wound is then closed as after any nephrotomy. It is a difficult operation.

(5) *Uretero-pyeloplasty* (*Finger's Operation*).—The pelvic dilatation is due to the stricture at the beginning of the ureter (Fig.

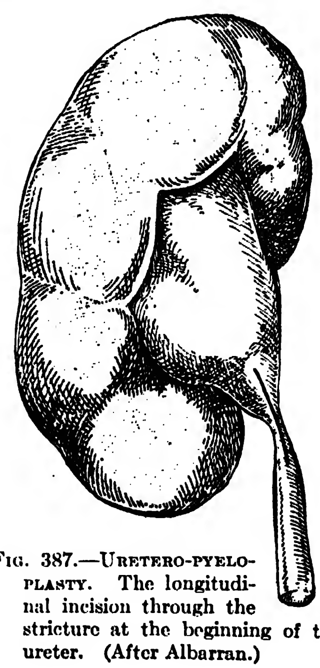


FIG. 387.—URETERO-PYELOPLASTY. The longitudinal incision through the stricture at the beginning of the ureter. (After Albarran.)

387). This operation consists in dividing the stricture by a longitudinal incision, and then sewing it up transversely. Fig. 388 shows how the transverse sutures are placed and Fig. 389 shows them tied.

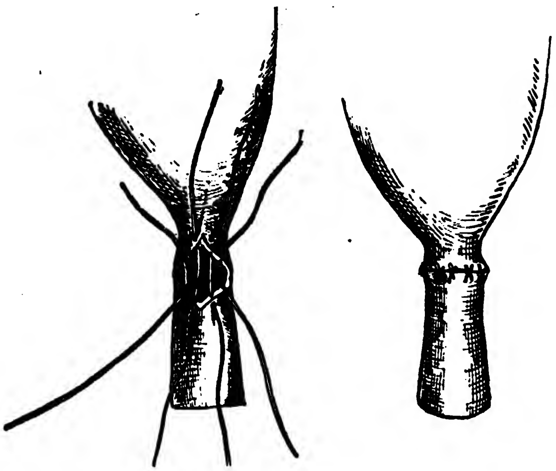


FIG. 388. FIG. 389.

FIG. 388.—URETERO-PYELOPLASTY. Sutures passed so as to leave a transverse wound. (Albarran.)

FIG. 389.—URETERO-PYELOPLASTY. Sutures ligated, making the strictured part of the ureter the widest part.

(6) *Lateral Anastomosis of the Pelvis and Ureter.*—Cystoscope the patient and catheterize the ureter. Perform a nephrotomy. Approximate the lowest end of the pelvis with a corresponding part of the ureter and make an incision in the pelvis at this point and also in the ureter (Figs. 390 and 391). Bring the end of the ureteral catheter through the opening in the ureter, and in the renal pelvis and out through the nephrotomy incision. Then sew the back part of the incision in the pelvis to the back part of that in the ureter. Pass a fairly large fenestrated catheter over the smaller one from above through the opening in the kidney and pelvis into the ureter. Then sew the anterior part of the incisions in the ureter and pelvis together. Allow the fenestrated catheter to remain in for several days until a communication of large size has been made between the ureter and renal pelvis.

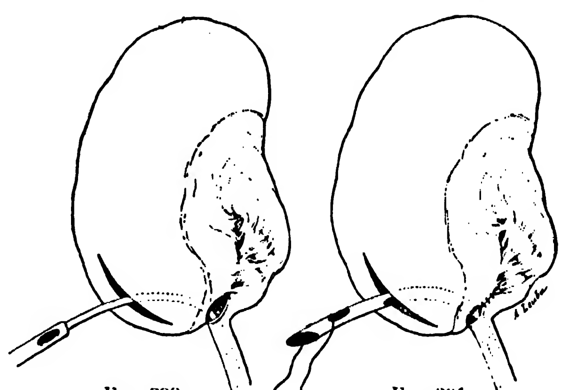


FIG. 390. FIG. 391.

FIG. 390.—LATERAL PELVIC-URETERAL ANASTOMOSIS. Showing the nephrotomy incision in the kidney convexity, the opening in the lowest part of the pelvic pouch and in the ureter joining it, also the ureteral catheter *in situ*. (Albarran.)

FIG. 391.—LATERAL PELVIC-URETERAL ANASTOMOSIS. The wound united.

(7) *End-to-end Anastomosis of Pelvis and Ureter (Trendelenburg's Operation).*—The ureter is cut through and the end nearest the kidney ligated. A triangular incision is made in the lowest part of the pelvis and the split end of the lower segment of the ureter is sewed in it by catgut and reinforced with silk (Fig. 392). Albarran does a nephrotomy before the anastomosis.

Drainage.—As has already been said, it is important to always cystoscope the patient and catheterize the ureter on the affected side before beginning the operation. The catheter goes through the ureter into the pelvis of the kidney. In all cases, excepting uretero-pyeloplasty, this should be done, and after which a catheter of large size, say 13 or 14 French scale, having been fenestrated, should be threaded over the end of the ureteral catheter in the loin and pushed with it through the operative field so as to obtain a larger anastomotic opening for drainage between the renal pelvis and the ureter. The incision in the kidney should then be closed to this drain. (See Fig. 390.)

A catheter 25 to 30 French, about a foot long, is then inserted into the wound down to the kidney and the abdominal incision is closed, excepting at the point at which the drainage tube and the reno-ureteral drain comes through.

While the lumbar drain is in, nearly all the urine escapes by this route. It is well to irrigate the operative field twice a day through the ureteral and loin catheters, with boric acid if the urine is clear, or with a 1:1,000 solution of silver if it is turbid. This washes away obstructions and prevents infection. The large kidney drain is removed on the third day in hydronephrosis and on the sixth day in pyonephrosis; the catheter in the pelvis usually three days later.

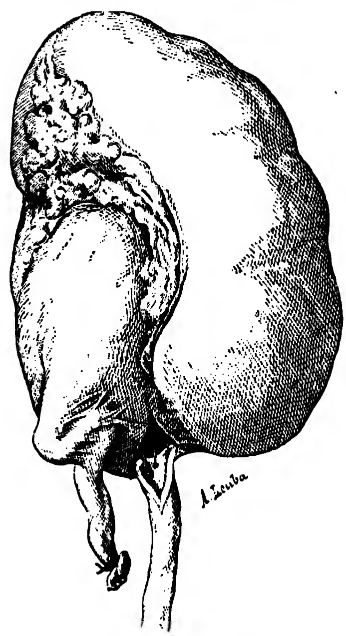


Fig. 392.—Kinked Ureter with Adhesions Amputated Below. The lower segment is partially united to an opening in the lowest part of the pelvic pouch. Note the triangular shape of the adjoining cut surfaces; a wider union is thus obtained. (From Albarran.)

When the progress is not satisfactory in the operative field, or there is danger of a stricture at the point of operation, it is better to leave the catheter in for three to six weeks. Sometimes the catheter does not fit well, in which case it can be removed and another inserted. In making this change, it is advisable to pass a mandrin into the catheter already in place, and, after having removed it, to keep the mandrin in place until a clean catheter has been passed over it to take the place of the one removed.

The withdrawing of the drain is sometimes followed by pain and fever. When a catheter has been left in the ureter that is not satisfactory, injections should be made or a mandrin passed. If no catheter has been passed into the ureter, this should be done, which will often reëstablish the drainage in a few days. If this is not done, it will be necessary to again open the lumbar wound, thus establishing a fistula. A few weeks later, again try ureteral catheterization.

CHAPTER XXXII

THE URETERS

ANOMALIES OF THE URETERS

OWING to the complexity of the developmental process, anomalies of the ureter are manifold. They may be classified into: Anomalies in number—a deficiency or an excess of ureter, anomalies in position, anomalies in caliber.

1. **Anomalies in Number.**—DEFICIENT URETER.—These are rare. The ureter and the kidney may both be absent, or the hilum alone is missing, the ureter coming directly from the anterior and lower part of the kidney.

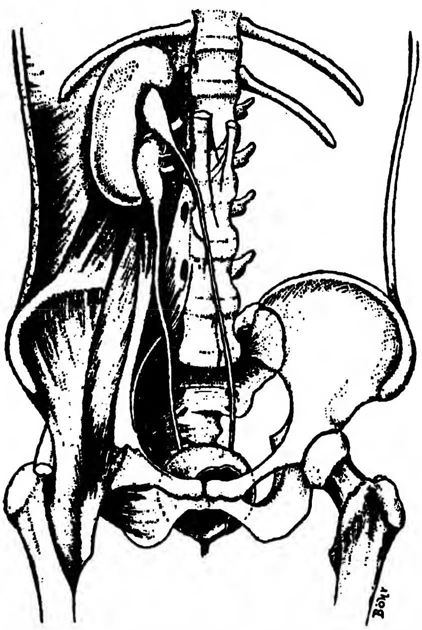


FIG. 393.—TWO URETERS EACH EMPTYING INTO THE NORMAL ORIFICES AT EITHER END OF THE TRIGONE, COMING FROM A SINGLE UNSYMMETRICAL KIDNEY ON THE RIGHT SIDE. (Pousson's case.)

An EXCESS OF URETER is much more frequent. Supernumerary ureters are found in three per cent of cases, according to Poirier. The supernumerary ureter may be bilateral, but it is more frequently unilateral. The double ureter may be complete, or it may affect only the upper portion of the canal. The supernumerary ureter is always placed above the normal one, and drains the upper part of the kidney.

Fig. 393 is in a single (unsymmetrical) kidney (Pousson's case). The ureters empty into the regular angles of the trigone. If it had been displaced down, it would probably have been a horseshoe kidney.

Supernumerary ureters have some surgical interest. If not strictured, or not ending abnormally, they do not cause any symptoms; but they are frequently strictured, causing partial hydronephrosis, or they may have abnormal endings. The portion of kidney drained by a supernumerary ureter may be infected alone, the other part being healthy. For this reason it is necessary to detect them, which has been done on the living by cystoscopy, ureteral catheterization and radiography. Cases have been seen

of partial gonorrheal pyelitis, of partial pyonephrosis, of partial tuberculosis, although very rare. Fig. 394 shows a double ureter on the left side, as seen by radiography after ureteral catheterization.

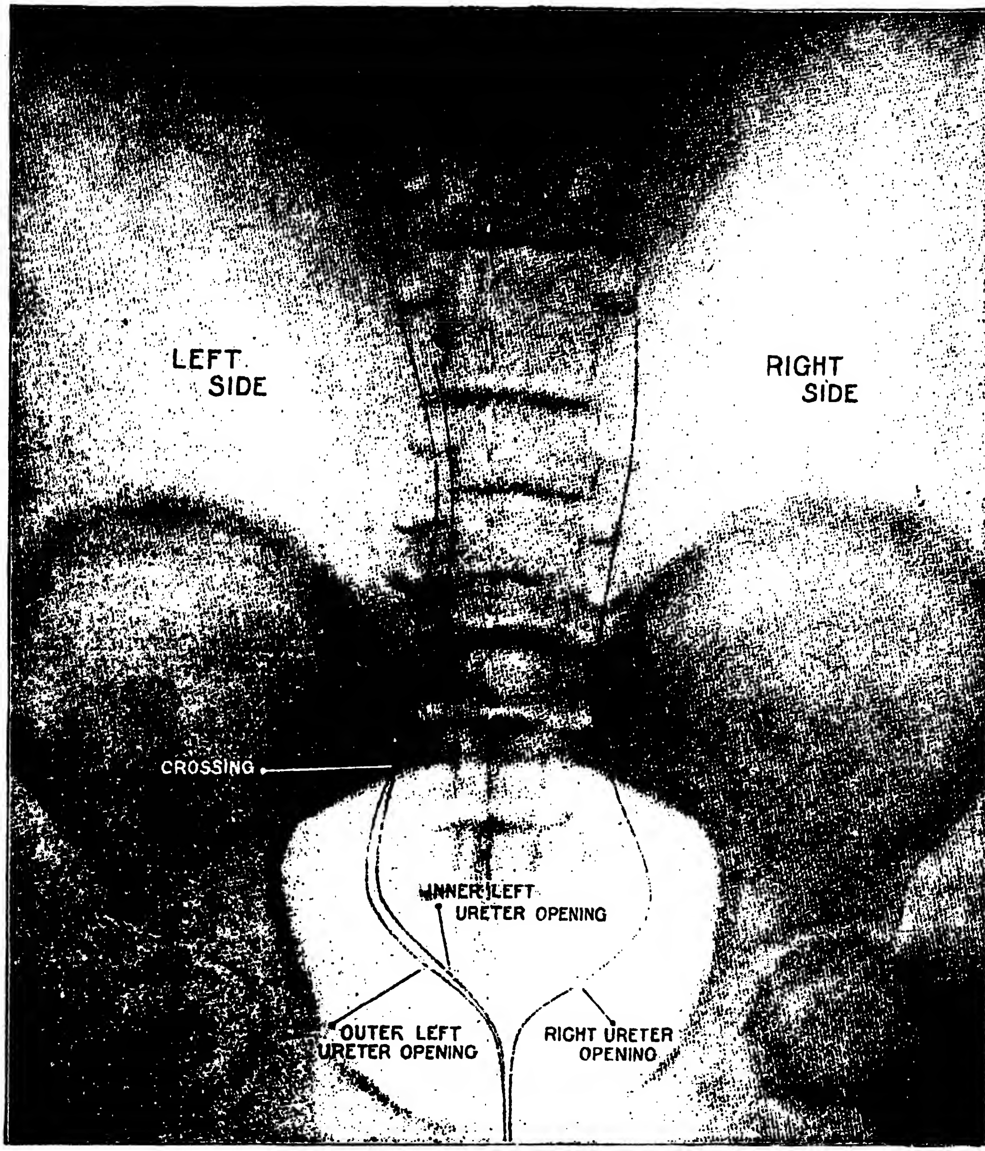


Fig. 394.—A Double Ureter Coming from the Left Kidney, as Seen by Radiography. (Bransford Lewis's case.)

2. **Anomalies in Position.**—In transposition at the hilum, the ureter is found lying in front of the renal artery.

Abnormal Endings.—The most frequent of the latter are in the prostatic utricle in men and in the anterior vaginal fornix in women. They have been

seen also in the seminal ducts and vesicles, in the rectum and in the Fallopian tubes. An ending in the urethra or in the vagina gives rise to a special variety of incontinence, the proper treatment of which is implantation of the abnormal ureter into the bladder.

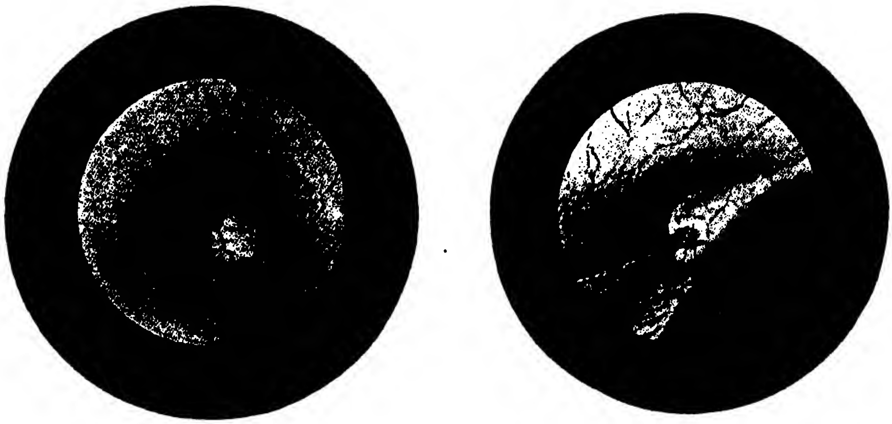


FIG. 395.—VESICAL ENDS OF THE URETERS PROLAPSING INTO BLADDER. (After Knorr.)

INTRAVESICAL PROLAPSE of the lower end of the ureter may be congenital, but it is also acquired in some cases. It varies in extent from slight bulging into the bladder to a large projecting mass. It is caused by a lack of support in the muscular tissues of the bladder wall and favored by too direct an entrance of the duct into this organ. The result is a stenosis of the orifice of the ureter with all the ordinary consequences. Fig. 395 shows the ends of the ureters prolapsing into the bladder.

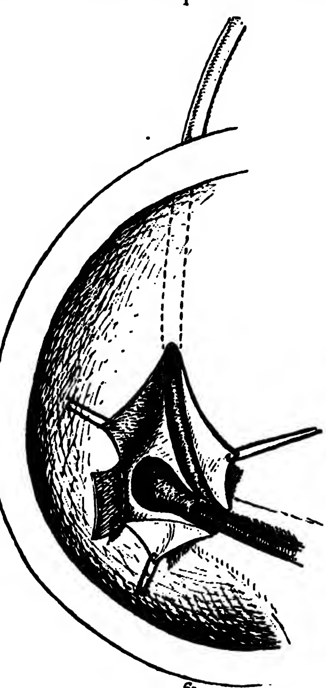


FIG. 396.—A DIVERTICULUM OF THE PART OF THE URETER PASSING THROUGH THE BLADDER WALL, PREVENTING CATHETERIZATION. (Author's case.)

The treatment for this condition does not offer much hope of improvement, if any. It consists of either shortening the ureter or uretero-cystostomy.

A DIVERTICULUM OF THE END URETER IN THE BLADDER WALL.—Fig. 396 shows an abnormal ureteral ending in a case of double sclerotic kidney in a girl sixteen years of age. The kidneys were two inches in length. On the left side was a spleen with a round border and narrow in its transverse diameter in which no notch could be felt. The girl had a slight polyuria and the case was diagnosticated as one of tuberculosis of the left kidney. On

cystoscopy, two ureteral openings were seen, but several attempts to catheterize the right ureter proved a failure, as the catheter only entered the ureteral mouth. There was no urinary swirl coming from that side and we were not sure that urine escaped or that the kidney was present. A number of consultants considered the case one of a probable tubercular kidney on the left side with a possible absent kidney on the right, and advised an exploratory incision on the right side to be followed perhaps by a left nephrectomy, but the patient died of uræmia before the consent of the family could be obtained. Autopsy showed a sacculation of the lower end of the right ureter.

3. **Anomalies in the Caliber.**—Anomalies in the caliber of the ureter are the most numerous of all and have been studied in the chapter on Hydronephrosis. The irregularity in caliber may be due to compression of the duct by an abnormal vessel. The principal causes of irregularity of caliber are in the wall itself: Stricture, congenital valves and the persistency of the fetal condition.

INJURIES OF THE URETERS

Accidental Wounds

Etiology.—Accidental wounds of one or both ureters are of exceptional occurrence. They may be the result of knife thrusts, of wounds from any sharp-pointed weapon, instrument or tool, or of gunshot injuries. The injuries are usually found in the immediate vicinity of the renal pelvis.

The **symptoms, diagnosis** and **treatment** of these rare cases are practically the same as those of wounds of the pelvis of the kidney. The **differential diagnosis** between injuries of the renal pelvis and the upper segment of the ureter is, indeed, clinically impossible without an exploratory incision.

The **prognosis** of accidental wounds of the ureter depends largely upon the timeliness of diagnosis and of operative treatment. When they are left to themselves, the prognosis of these wounds is extremely unfavorable, death or permanent fistula being a frequent outcome as, owing to the small size of the canal, its injury is frequently accompanied by fatal lesions of adjacent parts or organs. Penetration of the peritoneum often terminates in peritonitis and death. Localized lesions of the duct are followed by the establishment of permanent fistulæ, unless operated upon, or else the kidney on the affected side becomes obliterated. In the presence of sepsis or suppuration complicating such wounds, we may expect to see the obstruction of the proximal ureteral end; or the development of uretero-pyelo-nephritis, with its sequelæ of renal atrophy; or pronounced septicemia if there is retention of infected urine in the tissues; or a permanent fistula.

Less formidable wounds of the ureter, such as punctures, oblique divisions or clean-cut longitudinal incisions, are very infrequent. The prognosis of

operated cases, especially those attended to early, is, of course, much better, even when the wound is serious.

Treatment.—The treatment of accidental wounds of the ureters may be summed up as follows:

If the peritoneum has been injured, open the peritoneal cavity and examine its contents for other injuries which should be repaired as indicated. If a local collection of pus or urine is present, sponge it dry, then sponge it with salt solution and afterwards with peroxid of hydrogen. If the ureter can be more easily operated on through the abdominal incision, perform the operation of ureterorrhaphy, uretero-ureterostomy, uretero-cystostomy, if in the lower part of the ureter. Then make extraperitoneal drainage and close the peritoneum over the seat of operation. Intraperitoneal drainage down to the seat of injury may also be used, especially if there has been pus in the wound or urine.

In case the wound is in the upper segment of the ureter where a loin incision would better expose the ureter, it is advisable to treat and close the peritoneal wound as already indicated and then to open the loin and do the ureteral operating through the lumbar incision.

If after opening the peritoneal cavity it is found that the peritoneum and the contents of its cavity are not involved, no intraperitoneal drainage is required and the wound can be closed and all the work done by the extraperitoneal route, drainage being kept up through the outer incision until urinary leakage has ceased.

In any case, wherever the operation is performed, a ureteral catheter should be passed by cystoscopy up and through the injured portion of the ureter before the operative work is begun, and it should be retained afterwards for draining the urine from the kidney past the seat of the ureteral operation.

Operative Injuries

Operative injuries of the ureters are quite common and should be repaired as indicated at the time of the accident.

Accidental injuries usually occur in: Operations on the female generative organs such as fibromyotomy, salpingectomy, salpingo-oöphorectomy, oöphorectomy, vaginal or abdominal hysterectomy; operations during labor and use of forceps; operations on the rectum or sigmoid.

Symptoms.—The symptoms of operative wounds of the ureter are apt to be obscure and indefinite, until the escape of urine becomes manifest either in the vagina, or in the peritoneal cavity. Leakage into the peritoneal cavity is followed by a train of symptoms varying according to the normal or septic condition of the urine. Acute general peritonitis may arise in either case; but it will surely follow infection with septic urine, in which case the symptoms of

general peritonitis will be present. Normal urine, under favorable conditions, may be tolerated by the general peritoneal cavity, becoming partially absorbed, or occasionally draining through the abdominal incision.

Localized peritonitis, subacute or chronic, may develop as the result of the accumulation of urine in a definite area of the peritoneal cavity, especially when susceptibility to infection is increased by the presence of adjacent raw surfaces or of loose adhesions. The usual outcome of this localized inflammatory process is abscess formation, circumscribed in character and ending in the discharge of pus and urine and the establishment of a septic urinary fistula at the site of the spontaneous or artificial rupture of the abscess.

Diagnosis.—The diagnosis of operative injuries of the ureter is usually easy, on account of the direct ocular evidence of the accident. When its occurrence has not come at once to the operator's attention, when the ureter has been ligatured by mistake in place of or together with the uterine artery, or has become occluded by the compression of ligatured adjacent tissues, the diagnosis is not so easy. In the first instance, no discharge of urine through the vagina is noted until an abscess has formed, or it has ruptured, or until the sloughs have begun to separate and a fistula has formed; whereas in the second instance, an occluded ureter would give rise to renal pain and ureteral catheters would find the obstruction. Both ureters have been completely divided during the performance of major abdominal operations, without giving rise to any immediate symptoms.

Prognosis.—The prognosis of operative injuries of the ureter is favorable both as to the prolongation of life, and also as to the preservation of the kidney, provided the injury is at once detected and properly repaired. Complete division of the ureter has been treated successfully by prompt ureteral anastomosis by one of the methods described farther on. Incomplete division of the ureter naturally offers even more encouraging prospects as to the preservation of the ureteral lumen and functions, provided prompt repairs be made. The prognosis is, of course, far more grave when septic peritonitis has set in, or when an acute infection has developed in the kidney. In such cases, an immediate operation is called for.

Treatment.—The management of ureteral injuries varies according to extent and direction of the lesion. The wound may be incomplete, with a longitudinal, transverse or oblique tear of the duct, or the ureter may be completely severed.

In incomplete longitudinal wounds of the ureter, spontaneous repair of the lesions may take place after establishing thorough drainage. It is advisable, however, to suture the ureter if accessible, after passing a ureteral catheter through the injured area from the bladder. Interrupted sutures of fine chromic gut are preferred. I do not believe in the Lembert method, as I fear it may cause stricture. Many prefer not to use sutures.

In uniting very short transverse wounds, where one third of the circumference of the duct, or less, is included in the lesion, ureterorrhaphy is performed. Instead of a stricture forming, the ureter will then present a dilatation at the level of the wound.

When the duct is completely severed, uretero-ureterostomy, uretero-cystostomy, or uretero-pelvic anastomosis should be performed according to the position of the injury, whether it be near the middle, upper or lower end of the ureter. When the continuity of the ureter is destroyed, it is essential to determine the presence or absence of an extensive loss of substance. Even when the two ends are rather widely separated, they can often be approximated. In virtue of its elasticity, the ureter can actually be stretched to an average extent of about 8 cm. for the entire canal without diminishing its caliber or interfering with its functional activity.

In performing an end-to-end anastomosis, uretero-ureterostomy, the Poggi operation is the one of choice. In this case the ureteral ends should be cut off squarely before uniting the two segments.

When the wound in the ureter is partial and oblique with fairly even edges it can be united by suture or can be allowed to heal without suture; but in either case with a retained catheter in the ureter. It is in the cases of the oblique wounds in which an end-to-end anastomosis is to be performed that Bovée's operation may be of great service, as the uninjured side of the ureter can be cut through in a line corresponding to the oblique line of the wound and then the Bovée anastomosis made. All these methods are explained in the chapter on the Operative Surgery of the Ureter.

Contraindications to the suturing of ureteral wounds are general weakness of the patient, long duration of the operation in case of an operative traumatism, and very severe urinary infection. In these cases, temporary external drainage down to the seat of injury, together with a retained ureteral catheter, may be resorted to in case the injury is incomplete.

INFLAMMATION OF THE URETER

Etiology.—Inflammation of the ureter may be primary or secondary. Primary ureteritis is very rare. It may develop after an injury to the ureter, or about a stone impacted in the duct.

Secondary ureteritis may result from an extension by contiguity from a neighboring inflamed organ, or by continuity from some other part of the urinary tract. When it results from an extension by contiguity in men, it usually complicates a pelvic adenitis or proctitis. Such cases are very rare and the inflammation is more marked as a periureteritis than as a simple ureteritis. In women, the extension by contiguity is more common, on account of the in-

timate relations between the lower part of the ureter and the internal female genitals, and ureteritis has been found secondary to septic metritis due to childbirth and other causes, to a salpingitis, pelvic cellulitis, infected hematoma and cancer of the uterus.

Secondary ureteritis is, however, usually the result of an extension by continuity, either down from the kidney or up from the bladder. It is accordingly spoken of as ascending or descending, and it is still a question which of the two is the more frequent. Descending ureteritis is secondary to pyelitis, pyelo-nephritis, or pyonephrosis, which are due to obstruction, renal calculus, tuberculosis or tumor. The ascending ureteritis follows a chronic cystitis associated with obstruction, such as vesical calculus or tumor; hypertrophy, cancer or stone of the prostate; or stricture of the urethra of congenital, gonorrheal or traumatic origin. (See Fig. 397.)

FIG. 397.—URETERITIS AND ASSOCIATED PYONEPHROSIS. Showing the irregular dilated condition of the ureter and the dilated condition of the pelvis. (From Pousson.)

Secondary ureteritis may also be due to a partial or complete paralysis of the bladder, due to injuries or sclerosis or tumors of the spinal cord, which give rise to retention of urine, cystitis and pyelitis.

Pathology.—In cases of acute ureteritis, the ureter shows a swollen mucosa and narrowing of the lumen. This stage is rarely seen.

In chronic ureteritis, two varieties of ureters are seen. In the cases in which obstruction is the predominating feature, especially if situated low down in the canal and the ureter has had a chance to dilate before infection has taken place, the canal is a dilated, elongated, thin-walled and sacculated tube. The kinks between the sacculations are held by adhesions so that the latter are permanent. On the other hand, when the infection has taken place before the walls have had a chance to dilate, the ureter is a thick, rigid tube with occasional strictures due to inflammatory thickening.

It is remarkable what a degree of dilatation can take place in a short time in cases in which there is back pressure of urine, when the infection of the ureters has set in quickly. Fig. 398 shows the ureter of a patient on my

service at the Columbus Hospital who fractured his spine one month before death. The ureters are large, sacculated and inflamed, while his kidneys are in a quite advanced state of pyonephrosis.

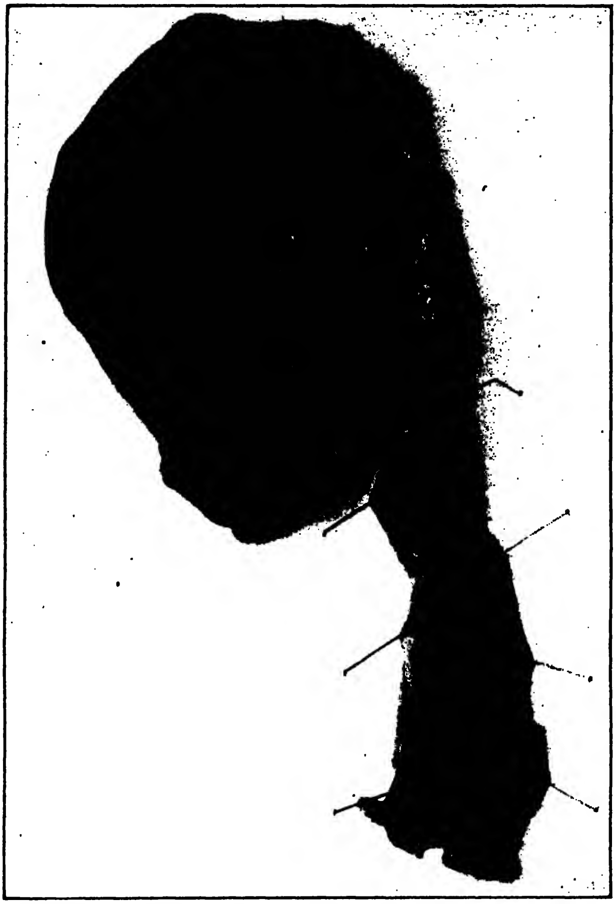


FIG. 398.— DILATION OF THE RENAL PELVIS AND URETER IN A CASE OF ACUTE URETERITIS OF ONE MONTH'S DURATION IN A PATIENT DYING ONE MONTH AFTER A FRACTURE OF THE SPINE. Autopsy specimen. (Author's case.)

Strictures of the ureter are most commonly found in the parts of the canal which are naturally the narrowest. The lesions of the mucous membrane resemble those of chronic cystitis, besides which there are two peculiar conditions that are occasionally observed, numerous small cysts and leukoplakia.

Symptoms.—As ureteritis is generally simply an extension of an inflammation from some other organ, it possesses almost no characteristic symptoms, excepting perhaps pain resembling a renal colic. Pain is always a symptom of ureteral obstruction. Abdominal palpation will sometimes detect an indurated or dilated duct. Inflamed ureters are also often felt by rectum or vagina. Pyuria is present, but it is difficult to differentiate the pus coming from the ureter from that coming from the renal pelvis. Cystoscopy may show the mouths of the ureter to be red and swollen, or dilated.

Treatment.—Preventive treatment consists in treating the bladder when it is inflamed. After the diagnosis has been made, the important part of the treatment is to remove the causative factor of obstruction by operations, such as urethrotomy, cystotomy and prostatectomy. If the kidneys are much involved, they should be treated by the method already outlined in the chapter on Suppurative Diseases of the Kidney. Irrigations of the ureters by the ureteral catheter can be made with solutions of silver nitrate from 1 : 8,000 to 1 : 1,000, or injections through the catheter of a small amount of ½ to 1 per

cent of protargol, or argyrol 10 per cent. Urotropin, salol, benzoate of soda are recommended as internal urinary antiseptics.

TUMORS AND CYSTS OF THE URETER

Tumors

Etiology.—These new growths are very rare, but when they occur it is always after thirty years of age. Ureteral calculus may be the cause, as a calculus of long standing may cause sufficient irritation and hardening of the tissues to predispose to malignancy.

Pathology.—Both the connective tissue and embryonic form of tumor have been found as primary or secondary growths in the ureters. Of the former class are papillomas and epitheliomas (Fig. 399). Of the second class are sarcomas, myxomas and rhabdomyxomas.

In case these growths are not primary, they are secondary by extension from the kidney, bladder or adjacent tissues. I have never to my knowledge had a case of primary tumor of the ureter, although I have had tumors of the bladder, that have involved

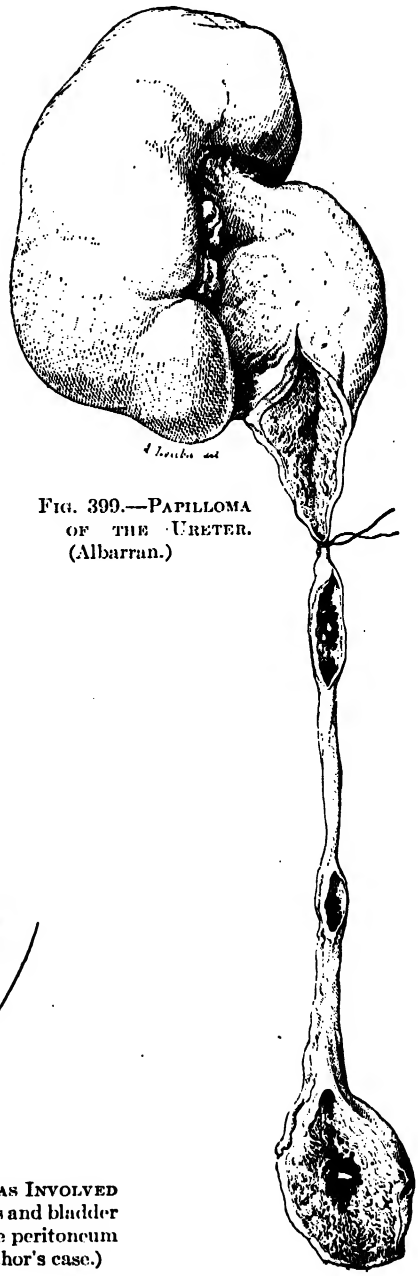


Fig. 399.—Papilloma of the Ureter. (Albarran.)

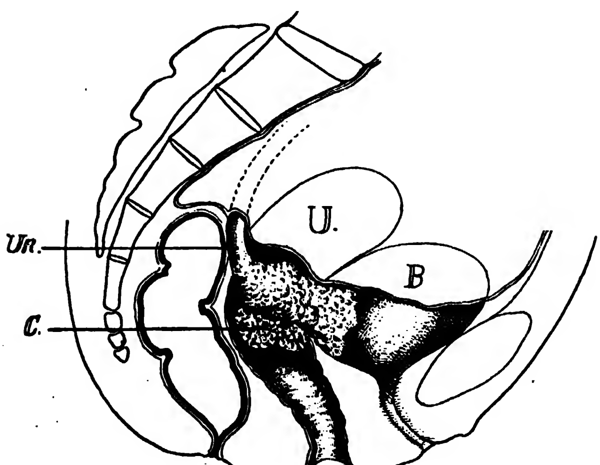


Fig. 400.—Cervix with a Cancerous Growth That Has Involved the Ureter and Bladder (*C*). *U* and *B* show the uterus and bladder covered by peritoneum; *Ur.* shows the ureter outside the peritoneum passing by the cervix in its route to the bladder. (Author's case.)

and occluded the ureter, and cancer of the cervix uteri, that has also involved it (Fig. 400, author's case).

Symptoms.—The principal symptoms are hematuria, swelling and pain, the same as in tumor of the kidney. Hematuria is usually the first symptom and may not be associated with pain. It generally comes on without cause, is profuse and thoroughly mixed with the urine.

The swelling can sooner or later be detected and may lead to renal retention, in which case the kidney can often be outlined as well. Pain may be present as a dull ache or it may be of a colicky nature.

Examination.—Examination of the urine may show red blood cells, ureteral epithelia, atypical cells and tumor fragments. Later, if infection takes place, pus will also be present.

Examination of the bladder may show tufts of the growth springing out of the ureter. Ureteral catheterization will show an impediment in the ureter. Recto-abdominal palpation may disclose the growth if it is at the lower end of the ureter, while abdominal palpation may reveal it when situated in the upper part of the canal.

After infection takes place, pyelo-nephritis or pyonephrosis will develop and there will be an elevation of temperature, besides which the kidney can probably be found enlarged on palpation. Palpation of the adjacent organs will also give us some clew to a secondary involvement from the uterus or gut.

Prognosis.—The prognosis is bad, as a pyelitis resulting in a pyonephrosis will destroy the adjoining kidney tissue.

Treatment.—Nephrectomy and total ureterectomy. When the growth involves a segment of the bladder about the ureter, that part of the ureter and also the adjoining part of the bladder wall should be removed.

Cysts of the Ureters

Etiology.—Cystic growths are usually found in the lower part of the duct. They are supposed to develop either from enlarged mucous glands or the epithelial spaces of Brunn, or else to be caused by parasites. The cause is, therefore, not yet determined. They are most probably caused by parasites, as psorosperms due to coccidia have been found in both the ureter and the renal pelvis. Small hydatid cysts are sometimes caught and retained in the ureter in cases in which a hydatid cyst of the kidney has broken into the renal pelvis. The most interesting case of chronic cysts of the ureters that I have known was one of Bond Stow's, in which not only were chronic ureteral cysts present in the ureters, but the patient had double ureters on both sides, all of which contained cysts.

Pathology.—The interior of the ureter is usually in a state of catarrhal ureteritis and appears studded with minute vesicles the size of a pea, of a yellow-brown color, which contain a transparent fluid.

Symptoms.—These cysts may give rise to no symptoms or there may be some pain or hematuria.

FOREIGN BODIES IN THE URETER: URETERAL CALCULI

Etiology.—A stone may form primarily in the ureter, but such primary ureteral calculi are very rare. They are generally small and of a phosphatic composition. Nearly all ureteral stones are secondary, that is, they are formed in the kidney and while descending along the ureter have become impacted at some point, usually one of the narrow parts of the passage.

The etiology of ureteral stones is, therefore, that of renal calculi; but we have to mention here the factors favoring impaction which are the size, the irregular outline and the rough surface of stones. These set up a continuous irritation of the ureteral wall, followed by spasm; later inflammatory changes of the wall, until at last ulcerations and cicatricial strictures are produced, all of which contribute to make the impaction tighter and more permanent. Previous attacks of ureteritis and kinks of the canal also favor impaction.

Once impacted, the stone grows by the deposit of additional layers and usually assumes an oblong shape. The above-mentioned lesions of the wall may go on to pressure atrophy, to perforations with periureteral abscess and urinary infiltration, although abscess formation and urinary extravasation are exceedingly rare.

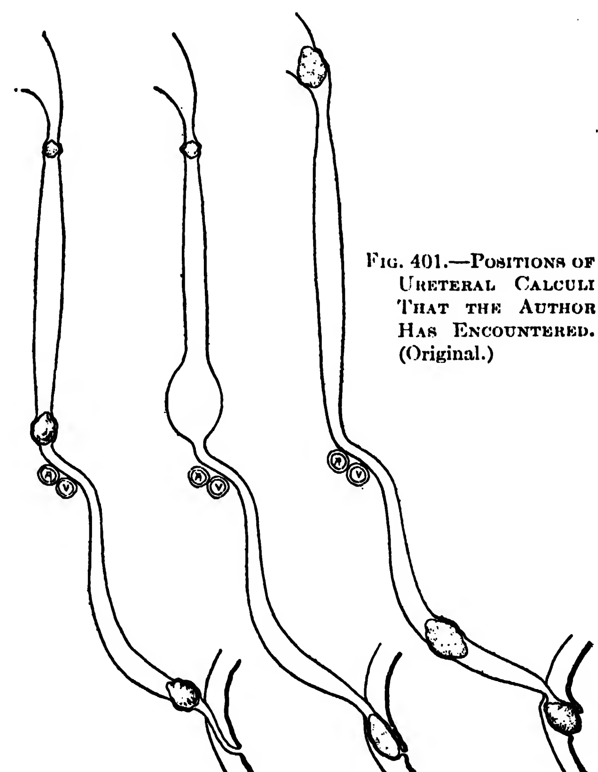


Fig. 401.—Positions of Ureteral Calculi That the Author Has Encountered. (Original.)

While impaction may occur at any point in the duct, the accident is more common at its narrowest parts, which are either immediately below the renal pelvis, just above the entrance into the bladder or in the middle third of the duct. In the lower portion of the duct, a calculus may be arrested near the ischium, near the outer bladder wall, in the part passing through the bladder wall; or a calculus may

be in the vesical portion of the ureter, protruding into the bladder cavity. Fig. 401 shows the position of stones that I have encountered in practice.

Character of Calculi.—Calculi met with in the ureter vary considerably as to form, composition, size and number. They are usually no larger than a cherry pit, but they have been met with as large as a hen's egg. Their composition resembles that of renal and vesical calculus (uric acid, urates, phosphates and calcium oxalates), their consistency varying with their chemical character. They are usually single, but may be multiple with facets adjusted to each other. Civiale observed seven stones arranged in this fashion and Cruveilhier mentions a series forming a long chain from the renal pelvis to the bladder.

Symptoms.—All ureteral calculi do not always present the same clinical symptoms. They may be of the *transient* variety, passing through the canal in from a few hours to a few days, accompanied by colicky pains and often hematuria; the *complete obstructive type giving rise to anuria* in certain conditions, and *latent* calculi that remain in the ureter for a long time and permit the passage of urine by their sides. In some cases, there are no symptoms of ureteral calculi, whereas in other cases they are most alarming. We can dismiss the consideration of transient calculi in a few words by saying that they are simply small renal calculi passing through the ureter; that their symptoms are then those of renal calculi and are considered in that chapter.

We will now pass to the consideration of latent ureteral calculi and reserve that of the complete obstructive calculi causing anuria for the last, as it is the most important.

Latent ureteral calculi are not always small concretions, as one of the largest calculi in Israel's records measured seven inches in length and two and one half in circumference and had given rise to but few symptoms. In latent cases, the ureter is only partially occluded and consequently some urine leaks between the stone and the ureteral walls. If these cases are not relieved surgically, the obstruction is sufficient to give rise to uronephrosis and later to pyonephrosis, if infection takes place, as it usually does. There may be slight pain along the course of the ureter in these cases and a history of renal colics and of calculi having been passed, but no other symptoms. The course of chronic cases of ureteral stone is generally long and may cover a number of years.

Diagnosis.—The diagnosis of ureteral calculi in latent cases is always difficult and depends upon a thorough examination of the patient. It was still more difficult before radiography was introduced. Now, when we are suspicious of a ureteral calculus, the patient is radiographed and the shadows of calculi looked for. It is sometimes difficult to interpret the findings, first, because certain ureteral calculi on account of their composition do not cast any shadows; second and more frequently, because many objects cast a shadow near and apparently inside the ureter that are not calculi. Many of the calculi are stopped

in the iliac portion near the point where the ureter crosses the big blood vessels and here calcareous concretions in the wall of the artery, phleboliths in the vein, small bony prominences and calcified glands have all been mistaken for calculi, as are the deceptive shadows given by a defective plate. In one case in which some of the best radiographists in the country told me that there was a stone in the ureter at the pelvic brim, I found at operation that there was simply a spindle-shaped collection of pus at this point. Sometimes shadows are seen near the ureter and then the question arises whether they are really calculi, and, if they are, whether they are contained in a sacculation of the ureter or in a supernumerary ureter.

In order to ascertain the real condition, cystoscopy and ureteral catheterization are very important. If the ureteral catheter is stopped at the point where the calculus is supposed to be, and if a wax-tipped catheter shows a definite scratch, the location of the calculus may be quite accurately determined. If all the data agree, then the diagnosis becomes more likely. If there is a difference between the X-ray findings and those of ureteral catheter, the examination should be repeated. In doubtful cases we can resort to an exploratory incision, provided the symptoms warrant it, which will also serve as the first step of the operation in case a calculus is found. X-ray plates should be made with a catheter in the ureter, as this shows the relation between the suspected stone and the ureter quite definitely.

Anuria is the alarming symptom of ureteral calculus. Both ureters are sometimes blocked by calculi, causing anuria, but such an event is very rare. It usually occurs after the blocking of one ureter. Formerly such cases were described as reflex anuria; but I now firmly believe that the unilateral blocking of a ureter causes surgical anuria only when the other kidney is anatomically absent, or its functionating power is temporarily or permanently destroyed. This is important to remember as having a bearing upon the emergency treatment of calculous anuria. It is not necessary for a large stone to block the canal in order to have anuria, as the greatest danger comes from a medium-sized stone that completely obstructs the canal (Fig. 402).

Fig. 402.—Actual Size of a Stone Giving Rise to Calculous Anuria. (Pousson's case.)

We shall not describe here in full the symptoms of calculous anuria. They are those of anuria in general. The duration of calculous anuria varies considerably, according to cases; sometimes, after a few hours, the calculus is voided with symptoms of ureteral colic and a postanuric polyuria may be observed, when it should be considered a transient case. In other cases, the anuria persists for days and even for two weeks. (See chapter on Nephrolithiasis, page 522.).

The *diagnosis of cases of calculous anuria* must be made quickly, as a mistake may be very costly. The questions we have to consider are the following:

Is the anuria due to calculous disease and is the blocking bilateral or unilateral? If the latter, is there another kidney and what is its condition? Lastly, what should be the nature of the operation?

It might be well to relate here the general course of events that I have noticed in the handling of such cases by the general practitioner and the urinary surgeon.

When a patient on arising in the morning cannot pass water and goes through the day without urinating, toward evening he becomes rather alarmed over his condition, especially if, after trying to urinate, he cannot pass a drop and he has no sensation of pain nor vesical fullness. He sends for his physician who comes and passes the catheter and finds no urine in the bladder. The physician then asks him if he has had any pain or colic in the side or has ever had such an attack before. He may remember that he has had pains in the loins the night before or at some other time, or he may not. The physician then prescribes acetate of potash, gr. x or xv, or diuretin, gr. xv, every three hours, or theocin, a grain every hour. He palpates the kidneys and if one or both are tender he applies cups. If there are any symptoms of uremia or edema, he may give him some cathartic, as elaterium, gr. ¼, or jalap powder, gr. xxx, or a hot pack, or some pilocarpin. These having no effect, he has a consultation on the following day and the urinary surgeon is called. Sometimes the urinary surgeon is not called for several days until he has passed through the hands of several physicians and uremia is threatening or present. The urinary surgeon takes the patient's temperature, pulse and blood pressure, and palpates the kidneys and the ureters over the abdominal portion, and in the pelvic portion by recto-abdominal palpation in men and vagino-abdominal in women. If he detects an enlargement of both kidneys, or a tenderness over both kidneys in the loin or over the lower ends of the ureters by pelvic examination, he suspects the case to be one of bilateral calculous anuria; whereas, if he finds such symptoms of enlargement and tenderness on but one side, he considers it a probable unilateral calculous anuria.

He then examines the bladder by cystoscopy. If he finds the bladder empty and not inflamed, he looks for the mouths of the ureters and watches to see if there is any urine coming from them. If they are not secreting, he catheterizes the ureters. In case the catheter meets with an obstruction in both ureters he considers the case one of bilateral calculous anuria. In case that the catheter goes to the pelvis of the kidney on one side and no urine escapes and the second catheter enters the other ureter for a certain distance and then meets with an obstruction beyond which it does not pass, he believes that he has to do with unilateral calculous anuria, and that the patient has a functionally destroyed kidney on one side, and a functionally blocked kidney on the other side. In case the catheter goes to the pelvis of the kidney on each side and no urine escapes the anuria is not due to obstruction.

Treatment.—The medical treatment of transient ureteral stones or other foreign bodies of the ureter is the same as that outlined for renal colic due to stone (*q. v.*). The pain is treated with morphin and chloroform inhalations; if near the bladder, by massage of the ureter, by rectum in men and by the vagina in women. Severe hemorrhage can be treated with ergot. It would, however, be a most rare occurrence. If stones do not pass out, they become latent calculi and the obstruction of the flow of the urine will then probably cause a gradual destruction of the kidney on that side through pyelitis and pyonephrosis, and it is therefore advisable to remove the stone by ureterotomy. Nephrectomy must be performed only when the kidney has undergone considerable sclerosis and atrophy and has no more functional value.

In the case of the unilateral calculous anuria, the surgeon immediately performs a nephrotomy on the kidney with the blocked ureter and then awaits developments. If the calculus passes, as it probably will, then he allows the kidney to heal; but if the calculus is not passed, then he performs a ureterotomy and removes it.

If the patient has a bilateral calculous anuria, he might think it advisable to do a nephrotomy on both sides, or else, if one kidney was more enlarged and tender than the other, he might consider it wiser to do a nephrotomy on the kidney more involved first, and the one less involved at another time.

If he performs first a nephrotomy on one side, he follows it in a day or two with a nephrotomy of the other side. Personally, if I ever have a case of bilateral calculous anuria, I will do a double nephrotomy unless the patient is in such bad condition that it would be dangerous to operate on more than one side at a time.

In cases of anuria, the operation is an emergency one. It has been proposed to push an impacted stone back into the renal pelvis by the ureteral catheter, but this is not practicable. The intervention is nephrotomy, as has already been said, either unilateral or bilateral, depending on whether one or both kidneys are involved. After the establishment of proper drainage of the kidney, the symptoms of anuria disappear and the intense congestion usually subsides sufficiently in a few days to allow the calculus to pass. If it is not passed, then a secondary ureterotomy should be performed to remove it, after having again catheterized the ureter to discover if it is still present. These steps seem to me preferable to a primary ureterotomy.

One of the most interesting cases of latent ureteral calculi that I have had was one of double ureteral calculus situated on either side about three inches below the pelvis of the kidney.

The patient had had several attacks of pain on the right side during a period of two years, as well as an occasional feeling of uneasiness. There had been no symptoms on the other side. The urine showed a few pus cells from the lower urinary tract, a few blood cells, renal epithelia and hyaline and granu-

lar casts, showing aseptic interstitial renal changes. Cystoscopic examination showed a healthy bladder. The ureters were catheterized and no obstruction was found. Radiography showed a stone in each ureter three inches below the pelvis (Fig. 403). The patient was treated for some time by flushings of various mineral waters and internal remedies and the question then arose as to the best operative procedure in his case. The probabilities were that the calculi

IG. 403.—CASE OF DOUBLE URETERAL CALCULUS. Each situated about three inches below rena pelvis. Radiographic picture. (Author's case.)

would gradually work themselves down to near the bladder and there remain unless operated upon. It, therefore, seemed advisable to operate in the position in which they then were. I accordingly did a double loin ureterotomy at one operation, removed both calculi, closed both ureteral wounds by ligature, leaving a drain in each wound down to the ureteral opening. One ureter closed in ten days, the other in four weeks.

The other foreign bodies in the ureter are of much less importance. First to be considered are blood or pus clots and impacted mucous secretions. Second, foreign bodies that have been introduced through the ureter, as pieces of a broken catheter. Blood clots or some foreign material entering from the out-

side, as spicules of bone, tissue or clothing, due to traumatism, may cause obstruction; the former through becoming surrounded by urinary salts and forming a calculus, the latter through forming the nucleus of a calculus or by causing a raw surface on which urinary salts can be deposited in connection with mucus or pus. Both of these conditions of traumatism would be more likely to occur when strictured or sacculated ureters are wounded than in the normal state and are causative factors.

TUBERCULOSIS OF THE URETER

Etiology.—The study of tuberculosis of the ureter is to-day of but little importance, as the disease usually occurs first in one kidney and then descends through the ureter to the bladder, and the rule of renal surgery is to remove a tuberculous kidney as soon as the diagnosis is made, providing the other kidney is sufficiently healthy to carry on the process of elimination. A tuberculous ureter is therefore but an appendage of a tuberculous kidney and should be considered as such. It usually atrophies as soon as the kidney heals, ceases to functionate, or is removed. Primary tuberculosis of the ureter almost never occurs and secondary tuberculosis is therefore the form to be considered.

Secondary tuberculosis of the ureter has been known to follow tuberculosis of some of the neighboring tissues, as tuberculosis of the spine; but it is almost always secondary to a tuberculous infection of the bladder or kidney. In the former instance, it is called ascending, and, in the latter, descending tuberculosis. It is very difficult for a tuberculous infection to travel up from the bladder against the urinary current, whereas it is comparatively easy for it to descend from the kidney. Ureteral tuberculosis is consequently in most cases a secondary descending process from the kidney. As renal tuberculosis is unilateral in over fifty per cent of the cases that we see clinically, ureteral tuberculosis will probably be found on but one side in the same proportion of cases.

The entire length of the ureter is more commonly involved than local areas of the canal. When the lesions are situated, however, in but one part of the ureter, they are usually found near the upper or lower end, in which latter case, as when it involves the entire canal, the infection extends to the bladder.

Pathology.—Tuberculous ureteritis begins with miliary granulations upon the surface of the mucosa, which later coalesce and ulcerate. Deep-seated tuberculous infiltration may take place, giving rise to elevations and protrusions into the canal which may obliterate the lumen. The whole extent or only isolated foci of the ureteral tract may be involved. Complete obstruction may occur through cicatrization, or occlusion of the canal by the protrusions associated with deep-seated infiltration, and the ureter may finally become merely a thick, fibrous cord.

As the tuberculous changes may be arrested at any period in the process,

the appearance of the ureter and kidney at autopsy varies according to the locality and character of the involvement. In some cases, the two ureters and kidneys may present an entirely different aspect.

If the process is localized, the tuberculous thickening usually occurs at the ends of the ureters, in which case the canal above may be dilated and its surface occupied by superficial ulcers (Fig. 404). If the upper part of the canal is involved, the effect is the same as if the whole ureter were thickened and dilatation takes place in the renal pelvis. More frequently, the whole ureter is involved, the tuberculous infiltration with thickening and mixed infection resulting in a short, thick ureter.

Fig. 404.—Tuberculosis of the Ureter. The right shows a stricture just below the pelvis and a tuberculous thickening just above the bladder. Between these two points is a dilatation of the canal and a flat tuberculous ulcer.

The tuberculous infiltrations develop so rapidly and are at times so packed in the canal, that occlusion, unilateral anuria and atrophy of the kidney on the affected side occur. If the process is slower and the obstruction less, the urine continues to flow through the ureter, but the impediment will suffice to cause back pressure and pyonephrosis. Tuberculosis of the lower part of the ureter extends to the bladder, where it is seen in the form of tubercles and ulcers about the mouth of the ureter on the trigone.

Symptoms.—The symptoms of ureteral tuberculosis closely resemble those of renal tuberculosis in that they are usually not marked and often absent. The characteristic renal pains may be present in a pronounced form, or else

entirely absent, when the disease progresses slowly. Renal colics sometimes occur, due to passing masses of *débris* from the kidney through a strictured ureter. Sometimes there is a dull pain radiating from the iliac fossa toward the groin or the bladder, or else up toward the lumbar region. This pain may be intensified by deep pressure over the kidney. Pain in the bladder with tenesmus and frequency of urination, which occurs when the process has reached the bladder, may be the first symptom of tuberculous ureteritis.

Examination.—The thickened ureter can sometimes be felt through the abdominal wall and is tender on pressure; whereas, in more advanced cases, it is a tough fibrous band. In women, bimanual palpation will sometimes show *per vaginam*, a large tender ureter, when the lower end is affected. In men, it is more difficult to palpate the lower end of the ureter by rectal touch, although, if pressed upon, it may give rise to a pain radiating along the course of the duct to the bladder or kidney. A cystoscopic examination shows small ulcers about the mouth of the ureter if the whole duct or its lower end is involved.

Diagnosis.—The diagnosis depends upon our being able to palpate the thickened ureter in some parts of its course, together with the presence of a tuberculous kidney on that side and the presence of ulcerations in the bladder around the orifice of the ureter, as seen through the cystoscope. The passage of the ureteral catheter shows the narrowing of the lumen of the canal, and the urine drawn from the pelvis on that side contains tubercle bacilli.

Prognosis.—Tuberculosis of the ureter may undergo resolution as well as the kidney. After the corresponding kidney has been destroyed or removed, the ureter may be transformed into a band of fibrous tissue, or it may continue to discharge or form a pus sac in a part or the whole of the canal.

Treatment.—Remove the kidney if it be tuberculous, with a part or all of the ureter, if the other organ is normal. I have never had any trouble with the ureter after nephrectomy in these cases. I ligate it and cauterize the lumen of the stump just below the renal pelvis. I feel, however, that it is safer to attach the ligated segment to the skin or the external fascia in the loin, so as to be able to find it easily if pus or urine should accumulate in it.

STRICTURE OF THE URETER

Etiology.—Contractions of one or both ureters may occur at either end of the canal or in its middle. There are two forms of stricture—the congenital and the acquired. The congenital form is usually situated at the junction of the ureter with the pelvis. The acquired stricture usually occurs at one of the normally narrow points of the canal. Acquired stricture may occur at any age. It may be due to irregularities of the vascular supply, the canal being crossed and strangulated by an anomalous vessel. The stricture may also result from scar-tissue contraction following an ulceration in tuberculous ureteritis (Fig.

405) or an impacted calculus of the ureter. It may also be due to tuberculous deposits with thickening of the canal. In other cases, it may be caused by a periureteral thickening or adhesions, or due to an injured ureter with an accumulation of pus or urine about it. A stricture of one portion may be associated with the dilatation of another. In women, the right side is principally affected.

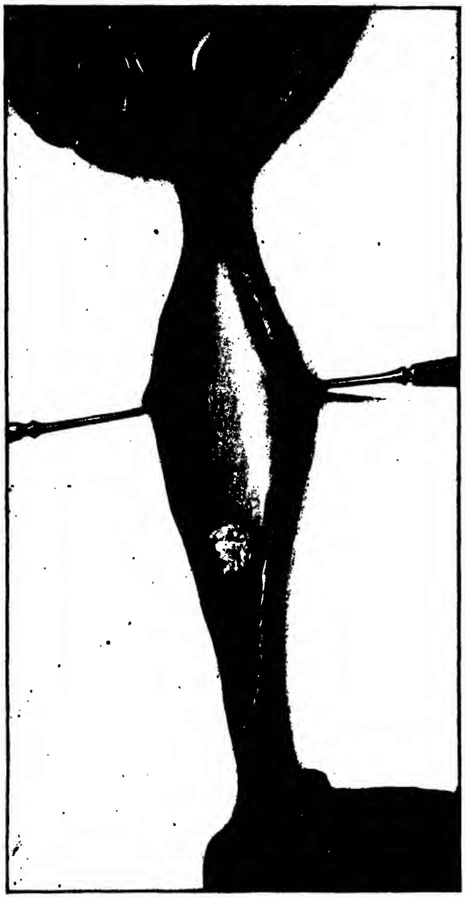


FIG. 405.—THICKENING, DILATION, ULCERATION AND STRICTURES THAT ARE SEEN IN FIG. 404, MORE CLEARLY SHOWN. (Author's case.)

Pathology.—A valve of mucous membrane is frequently found at the junction of the ureter and the renal pelvis, giving rise to obstruction. This may be either congenital, or acquired by pathological changes in the mucosa of the renal pelvis or the ureter itself. Ureteral valves have been observed in kinked and twisted ureters at the point of flexion.

In tuberculosis of the ureter, strictures are seen as the result of contraction of scar tissue after ulcerations. In other tuberculous cases, thickened ureters are found which are more marked in some places than in others, so that the lumen is either very much narrowed or totally occluded (Fig. 405). Irregularities and saccular dilatations with narrowing in places are seen in ureters as the result of long-standing inflammations (Fig. 397).

Symptoms.—The symptoms are vague, ill-defined and misleading. The associated complications are often more striking than the trouble itself. A partially obstructed ureter often gives rise to an enlargement and displacement of the corresponding kidney, in which case the organ can be felt as enlarged and tender on pressure. It may be accompanied by symptoms of malaise and tenderness, which condition subsides later temporarily. Occasionally the ureter above the stricture can be outlined as a very much dilated duct; but it occurs very rarely and I have never been able to palpate the ducts through the abdomen, even when autopsy has shown them to be much enlarged. Sometimes attacks of pain occur in the kidney on that side when small calculi, masses of

crystals or tuberculous detritus are passing through the strictured canal. Gastro-intestinal symptoms are sometimes observed, as are also peculiar sensations in the rectum.

Diagnosis.—Strictures of the ureter never exist without pathological conditions of other parts of the tract and the symptoms of this condition are identical with those of renal retention or hydronephrosis. The existence of the stricture and its exact location is frequently unknown until discovered by ureteral catheterization or in the course of surgical procedures.

Treatment.—Gradual dilatation by ureteral catheter may be of service in strictures that are neither very tight nor unyielding, but it is often useless and may cause traumatism. It should not be resorted to if it causes pain or fever. A longitudinal ureterotomy followed by a transverse suture is the most satisfactory procedure, unless there is too much thickening.

In stricture of the upper part of the canal, the duct may be divided and the end of the distal segment implanted into the lower part of the pelvis; whereas, when it is near the bladder, the end of the proximal segment may be implanted into the bladder in the same way. Resections with end-to-end sutures are indicated in stricture of the middle third of the canal. Nephrectomy can be performed in advanced cases of pyonephrosis in which the kidney is almost destroyed.

In conclusion, it may be said that the grave results of neglected ureteral stricture justify an exploratory operation in the loin whenever symptoms of ureteral stenosis are present that cannot be accounted for by the regular methods of routine examination.

FISTULAS OF THE URETERS

Fistulas of the ureters are communications between the ureters and either the skin or some hollow viscera in the abdomen or pelvis.

Etiology.—The causes of fistulas are either in the ureter or from the outside. The internal causes are the result of a perforation of the ureter, due to a tuberculous ulcer or an epithelioma, which has caused a local destruction of the wall; or else it is due to a stone which has caught in the canal and either perforated it or caused a slough, resulting in the urine leaking into the surrounding tissues. The sloughing of the ureter may also occur, due to a gravid uterus pressing upon it during pregnancy, especially when there has been a prolonged labor. It usually occurs on the left side where it is pressed upon by the fetal head.

Traumatic fistulas may be the result of any injury inflicted accidentally or during operation.

Pathology.—The urine, having leaked into the neighboring tissues, gives rise to urinary abscess, which points either on the surface of the body or some

mucous surface. The fistulous opening is either transverse or longitudinal, of variable shape and size. If longitudinal, the urine leaks from the sides of the duct; but if the wound has been transverse and complete, it will escape from the upper end, which may retract after the injury. Transverse wounds are usually the result of a surgical injury.

The place in which the abscess discharges is the distal end of the fistulous tract, as the abdominal wall anteriorly or posteriorly; or into the bowel, duodenum, colon, rectum; or into the stomach, the latter being extremely rare. Fistulas may also open into the vagina or into the uterus; and in some cases, when the rupture of the ureter is at the point where it enters the bladder, both the ureter and the bladder may empty into the vagina. The ureteral-vaginal and the ureteral-uterine fistulas are the result of lesions of the lower portion of the duct, while the cutaneous fistulas are nearly always the result of injuries to the upper portion.

When the wounded ureter makes a fistulous opening into the uterus or the vagina, the communication may be direct from one cavity to the other without any fistulous tract; whereas, in the middle and upper third of the ureters, an abscess always forms outside of the canal, resulting in the tract extending from the point of leakage in the ureter to the point of discharge. When the ureter has been severed and the two segments lie in the abscess cavity, the lower may become gradually atrophied. The fistulous tract is thickened, indurated and perhaps lined with granulation tissue, the same as the tract of any sinus.

Symptoms.—Constant leakage of urine is always present. The quantity escaping from a fistula which is the result of a complete transverse injury to the canal is greater than that coming from a ureter which has had only an injury of one side of its wall. After a kidney has been removed, if the ureter has not been tied, a urinary fistula may occur at the cut end of the duct and the urine may leak up through it from the bladder. This, however, is very rare, and is due to a dilated ureter, the result of obstruction lower down the urinary tract.

Ureteral fistulas rarely heal spontaneously. These fistulas are often complicated by recurrent abscesses, which tend to bring the patient's health below par. Strictures of the ureter also frequently occur at its point of leakage, and the resulting interference with the urinary flow may be so marked as to lead to hydronephrosis and suppurative disease of the kidney.

Diagnosis.—It is difficult to differentiate between a leakage coming from the upper part of the ureter and one from the pelvis of the kidney; it can simply be surmised by noting the direction of the fistulous tract, as it would require an operation and dissection along this tract to be sure as to the seat of the fistula. It is easier to distinguish the ureteral from the bladder fistulas, as in the latter case, if methylene blue is injected into the bladder, it will escape as a blue fluid into the fistulous opening. The tract of the ureteral fistula can also be discovered by injecting methylene blue into the tissues and noting if

it escapes from the uterine canal or the vagina in cases where such fistulous openings are suspected.

Prognosis.—The greatest danger of these fistulas is the formation of a stricture of the canal, causing obstructions which give rise to suppurative diseases of the kidney.

Treatment.—The management of ureteral cutaneous fistulas ranges from wearing some receptacle on the surface of the body to collect the escaping urine, to the removal of the kidney. Ureteral leakage caused by traumatism in the course of an abdominal operation should be repaired by suture. If it is a complete division of the ureter, the ends should be united by end-to-end or lateral anastomosis; whereas lateral leaks can often be repaired by suture. When these fistulas occur spontaneously, it is almost always due to impacted calculus, which should be removed and the duct then repaired by suture. While this operation is being performed and until healing takes place, a ureteral catheter should be retained in the canal. Sometimes if a catheter is simply retained in the canal for some time, it will allow a healing of a lateral injury. If the kidney has developed a suppurative process that is dangerous to life, it can be removed. If the urine continues to leak from the bladder through the ureter after a nephrectomy, the ureter should also be removed. Another method of treating such a case would be by the Watson operation, which comprises a lumbar incision, then ligating the ureter, opening the pelvis of the kidney by a vertical incision through the convexity of the kidney, inserting a drainage tube into the kidney pelvis and draining directly into the receptacle on the back of the patient. This would often save a large amount of functionating renal tissue that is lost by performing nephrectomy.

CHAPTER XXXIII

OPERATIONS ON THE URETER

The operations on the ureter are as follows:

Ureterotomy: Incising the ureter for ureteral calculus or stricture.

Ureterorrhaphy: Repairing partial ureteral wounds, that is, a ureter not completely severed, as those made during operations.

Uretero-ureterostomy: Implanting ureter into ureter. End-to-end anastomosis, usually performed for complete wounds of the ureter.

Ureterostomy: Implanting the end of the cut ureter into the skin.

Uretero-cystostomy, trans- and extraperitoneal: Implanting the ureter into the bladder. Usually performed for wounds of the ureter made during operation.

Uretero-vaginal anastomosis.

Uretero-intestinal anastomosis.

Ureterectomy: The removal of a part or the whole of the ureter. The former usually prior to an anastomosis, the latter after a nephrectomy for a tuberculous kidney.

Nephro-ureterectomy: The removal of both kidney and ureter at the same operation.

URETEROTOMY

Ureterotomy consists in cutting into the ureter, usually in the case of stone or stricture. In the first instance, it is spoken of as *uretero-lithotomy.*

Ureterotomy for Stone

Ureterotomy for stone, or uretero-lithotomy, will be the first considered, as it is performed in all parts of the canal and consequently shows all the various incisions that are employed.

The patient should be cystoscoped and the ureters catheterized. The incision is then made in the region that will give the easiest approach to the stone.

For stone in the upper part of the ureter, the regular curved lumbar incision is made in the kidney triangle, as for nephrotomy, with the patient lying face

downward with a pillow or sand bag under the abdomen, or on the healthy side with the loin supported. The ureter is felt for below the kidney. This can be easily found and delivered, especially if there is a catheter in the ureter. The ureter can then be freed and exposed from the kidney to the crest of the ilium by steadying the ureter with one hand and severing the tissues over it on the outer side with a thin knife or scissors (Fig. 407, A and B).

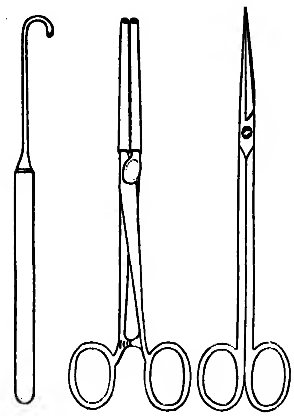


FIG. 406.—INSTRUMENTS FOR URETER OPERATIONS TO BE USED IN ADDITION TO THOSE ALREADY MENTIONED FOR KIDNEY OPERATIONS. *1*, Blunt hook. *2*, Ureteral clamp. *3*, Sharp-pointed scissors.

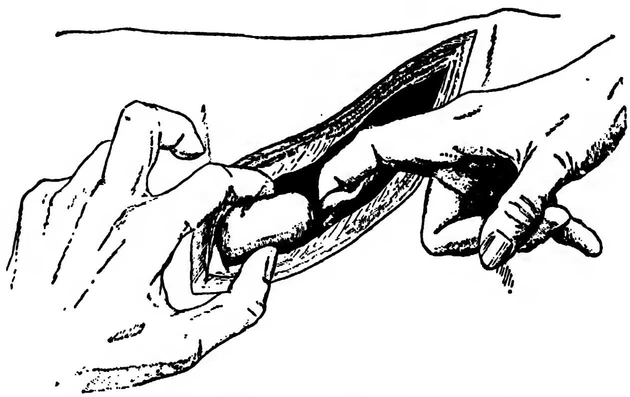


FIG. 407 A.—URETEROTOMY FOR STONE. Curved lumbar incision showing the delivery of the ureter below the kidney. (After Pierre Duval.)

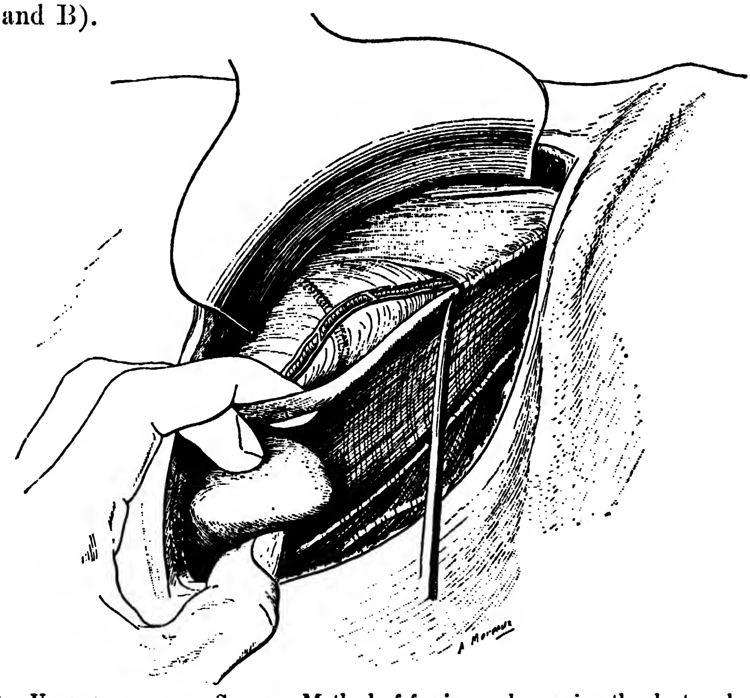


FIG. 407 B.—URETEROTOMY FOR STONE. Method of freeing and exposing the duct and enlarging the field prior to operation. (After Pierre Duval.)

For a stone in the middle or iliac portion of the canal, the patient is placed on his back and an incision made down to the peritoneum, either through

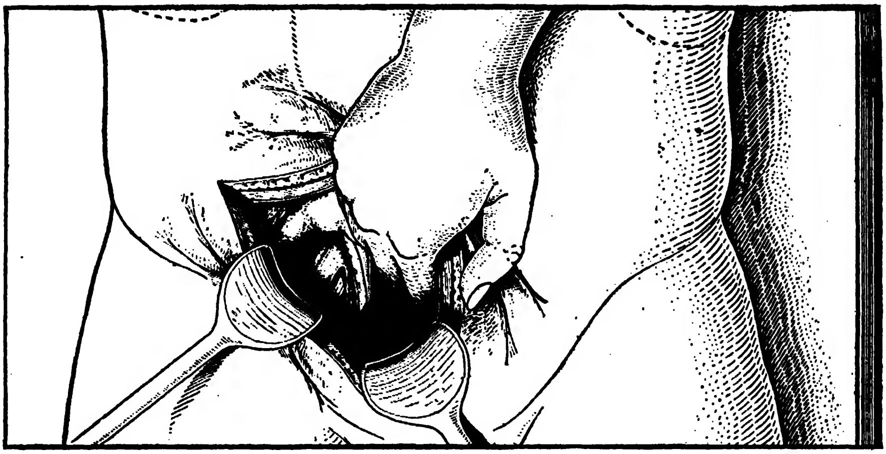
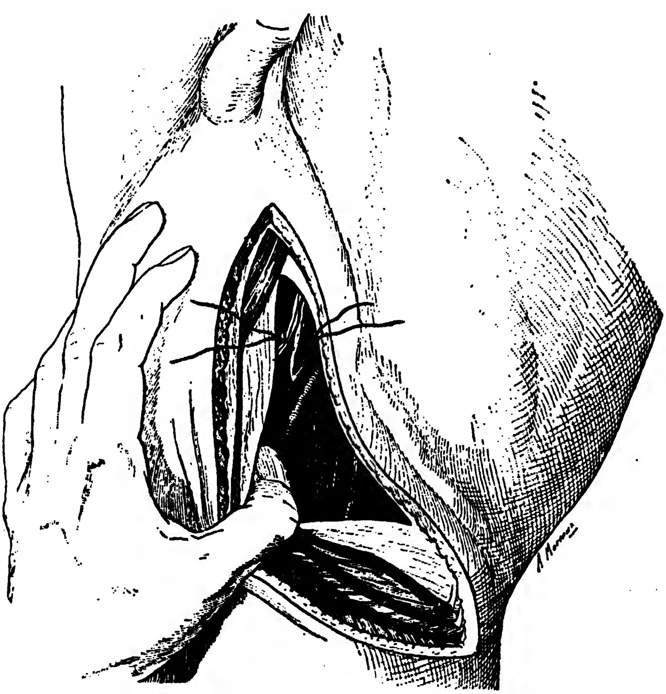


FIG. 408.—URETEROTOMY FOR STONE. Patient on his back and the incision made through the oblique and transversalis muscles in the iliac region, exposing the ureter as it crosses the pelvic brim and iliac vessels. The same exposure is obtained by an incision through the lower portion of the rectus abdominis muscle.

the oblique and transversalis muscles, just above Poupart's ligament (Fig. 408), or through the belly of the rectus muscle on that side.

For the operation on the lower or pelvic ureteral segment, the same incision should be made, but the patient should be placed in the Trendelenburg position and the epigastric artery ligated and cut (Fig. 409).

The perineal incision, with a dissection up between the prostate and the rectum, is another method of perform-



G. 409.—URETEROTOMY FOR STONE. Patient on his back, but in the Trendelenburg position. The same incision is seen and two ligatures are noted about the epigastric artery, which when ligated and cut will give a better field for working on the lowest segment of the ureter. (After Pierre Duval.)

ing ureterotomy on the lowest pelvic portion of the ureter in men. The vaginal incision is often employed for stones in this part of the canal in women.

The part of the ureter running through the bladder wall is best approached by a suprapubic opening of the bladder.

The calculus is usually at the lower end of the ureter. In aseptic cases, there is some thickening at the level of the calculus and some dilatation above it; whereas, in septic cases, there is an inflammation, thickening and perhaps a localized peritonitis and a stricture below the calculus. It is necessary to remove the stone to have the ureter drain the kidney well.

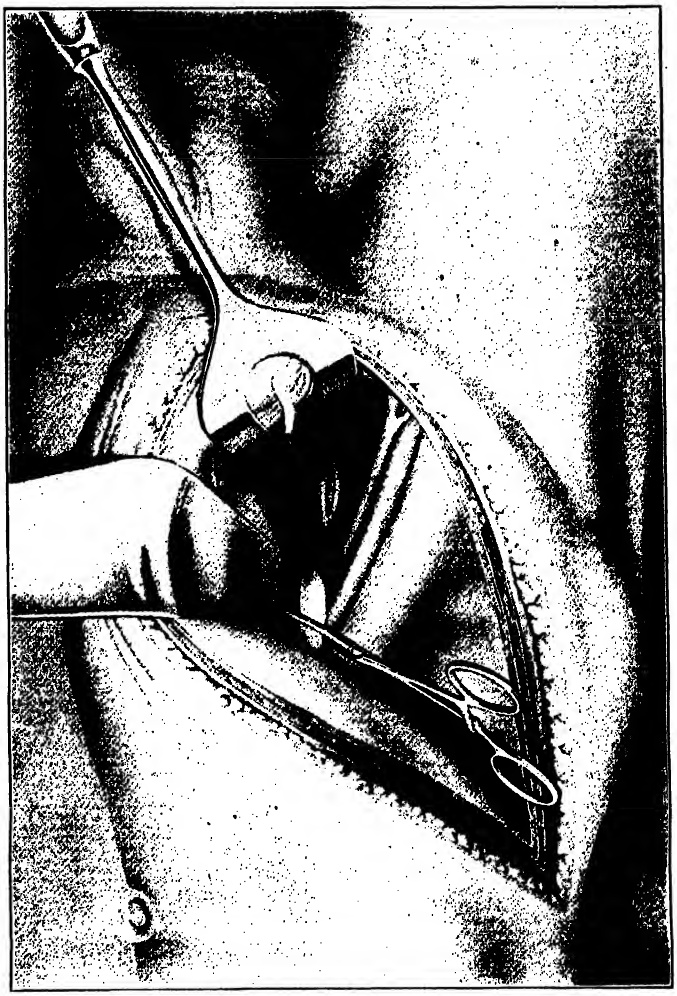


Fig. 410.—Ureterotomy for Stone. The same position and incision as in Fig. 409. A bulging of the ureter near the bladder with an incision in its wall shows a deep-seated calculus. A clamp has been placed above it to keep the urine from the wound during the operation. (Jeanbrau. L'Ass. Française d'Urologie.)

Technique of Operation through Abdominal Incisions (*Abdominal Ureterotomy*).—The patient is cystoscoped and the ureter catheterized, the catheter usually passing by the calculus. If it does not pass the stone, it will go as far as the point where the calculus is located.

Extraperitoneal Operation.—The ureter is approached by separating the peritoneum from the lateral or posterior abdominal walls and drawing it with its contents to the opposite side until the duct is seen in the region in which the stone is situated. The duct is then compressed above the calculus with a piece of gauze, tape or a clamp to prevent urine from leaking

into the wound, and the calculus is extracted by forceps; or it may be dislodged with a pair of blunt-pointed curved scissors (Fig. 411).

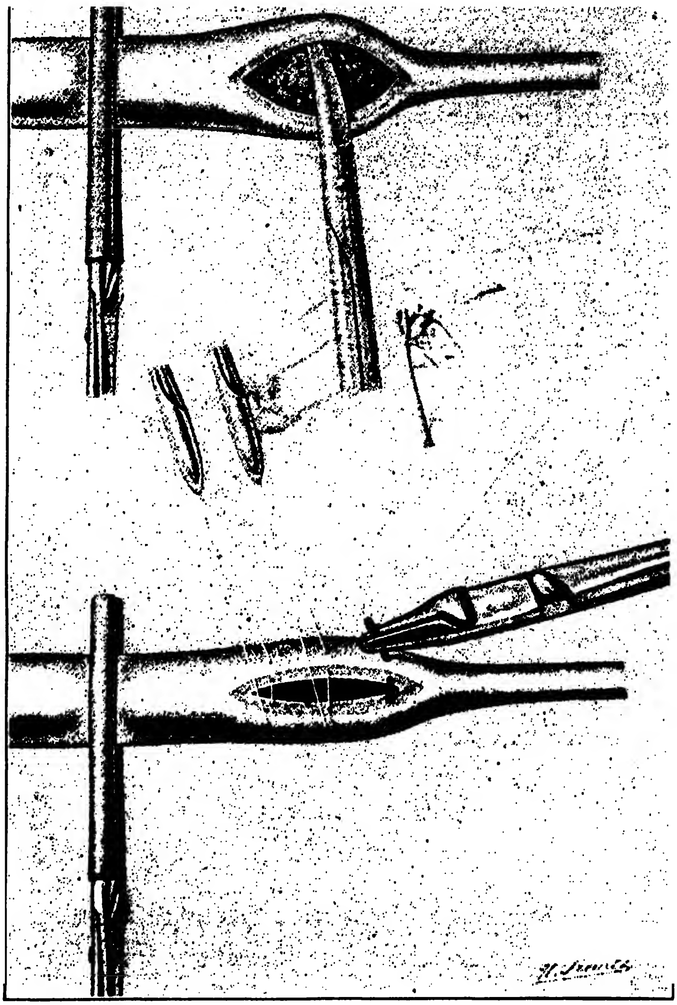


FIG. 411.—URETEROTOMY FOR STONE. The delivery of the calculus, the clamping of the ureter, and the suturing of the abdominal wall shown here applies to any part of the ureter. In the upper figure the calculus is being dislodged by blunt-pointed curved scissors, although forceps or very small dull curettes are generally used. The ureteral catheter can now be pushed up the canal and the duct closed by interrupted sutures of No. 1 chromic gut in a thin, round needle. (Jeanbrau. L'Ass. Française d'Urologie.)

In pus cases, it is necessary to proceed with greater care, as there is present a peri-ureteritis, the tissues are thicker and the traumatism connected with the operation is consequently greater.

In case there is no pus about the calculus, the ureter may be opened just

above it and the stone removed; but in case there is considerable pus in the cavity in which the stone is held, the duct should be opened over the entire length of the calculus.

Closing of the Ureter.—The ureter in clean cases is closed with interrupted sutures of the finest chromic catgut threaded in a fine round intestinal needle. As the duct is dilated above the stone, there is sufficient space for passing the sutures.

Many do not believe in sutures and prefer to leave the wound open. At the present writing, I think that it is better in all cases to close the canal entirely, or at each end, and to pass a drain down to it through the abdominal wall. Pus can drain along the ureter and, if the wound breaks down, the opening will not be so large as when the entire incision is left open. It is much easier to close the ureter when a ureteral catheter has been passed up the ureter before the operation (Fig. 411). If this has not been done, a catheter can be

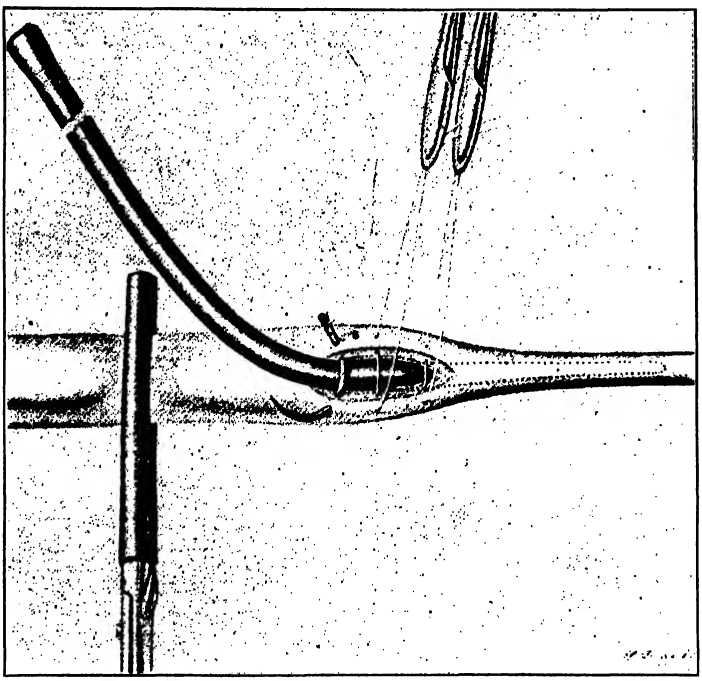


Fig. 412.—Ureterotomy for Stone. A ureteral catheter is an aid in suturing the ureter, but when it is not used, any small woven catheter should be passed into the ureter from the wound and removed as soon as the sutures are placed prior to ligating them. A ureteral catheter is preferable, however, both as an aid when suturing the duct, as a drain for the kidney, and to prevent contraction of the field of operation. (Jeanbrau. L'Ass. Française d'Urologie.)

passed down through the canal from the field of operation, as it is easier to suture the canal when an instrument is in it. The sutures are interrupted and pass through the entire wall excepting the mucous coat. In case a catheter has been introduced from the field of operation, it should be withdrawn before the su-

tures are ligated (Fig. 412). In any case, a ureteral catheter passed through the urethra and bladder by the field of operation should be retained for some time.

CLOSING OF THE ABDOMEN.—The drainage and the closing of the abdominal wound should be the same in septic as in aseptic cases, except that the wound should not be closed tightly up to the drainage tube; but space should be left for better placing the drain, as drainage will probably have to be kept up for four to fourteen days or longer. The ureteral catheter may have to remain in the ureter from a week to a month, according to the healing process. The ureteral catheter should be changed every few days or at least once a week, for the sake of cleanliness, even when it is working well. The renal pelvis can be washed out once or twice a day, according to the drainage, with warm water, followed by silver, 1 : 4,000, or protargol, 1 : 400.

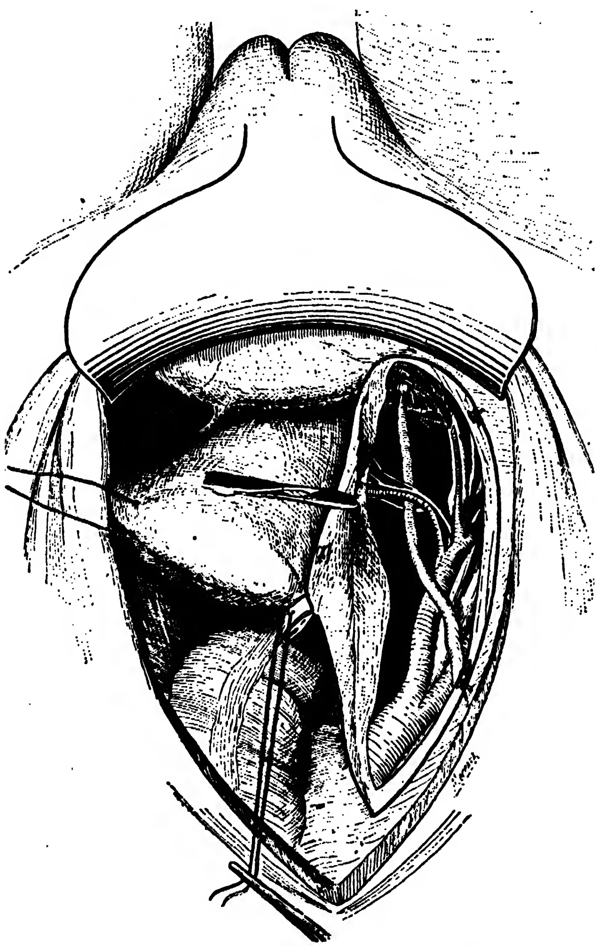


FIG. 413.—INCISION THROUGH THE BROAD LIGAMENT, EXPOSING THE URETER ON ONE SIDE. The round ligament has been cut through and the vessels about the ureter are seen. In this locality, ureterotomies, ureterorrhaphies, ureteral anastomosis, uretero-vesical anastomosis, uretero-intestinal anastomosis can all be done. When one of these operations has been performed, an extraperitoneal incision can be made for drainage through the loin, groin, or vagina and the peritoneum can be closed over the operative field. (After Pierre Duval.)

TRANSPERITONEAL ROUTE. — In women, the transperitoneal route seems to be the one of choice for pelvic work on the ureter for two reasons: First, because the injuries to the ureters usually happen during operations and are often seen; and second, because by the abdominal incisions, either through the oblique group of muscles or through the rectus, more difficulties are found in separating and drawing aside the peritoneum from the pelvic wall by the extraperitoneal operation than in men.

In the case of discovering later that a ureter has been injured during opera-

tion, it is easier to open the abdomen again and retrace one's steps than to try to find a partially wounded ureter or the segments of one that has been completely severed by the extraperitoneal route.

It is important in performing such operations in the female to remember that the pelvic portion of the ureter runs from the bifurcation of the iliac vessels to the base of the bladder, and that the portion of it in these cases that is liable to be injured is behind the broad ligament.

Fig. 413 shows a dissection through the broad ligament exposing the ureter on the left side. The round ligament has been cut through and the vessels about the ureter are seen. In this locality, ureterotomy, ureterorrhaphy, ureteral anastomosis, uretero-vesical anastomosis, uretero-intestinal anastomosis can all be done. After they have been performed, the peritoneum can be closed over the operative field and a drain passed down to the line of peritoneal closure through the abdominal incision. In cases with pus or pus in the urine, it is advisable, before bringing the peritoneum over the plastic work on the ureter, to make counter openings to the surface above Poupart's ligament if the operation is near the bifurcation of the iliac vessels, or through the vault of the vagina on that side if the operation is near or connected with the bladder.

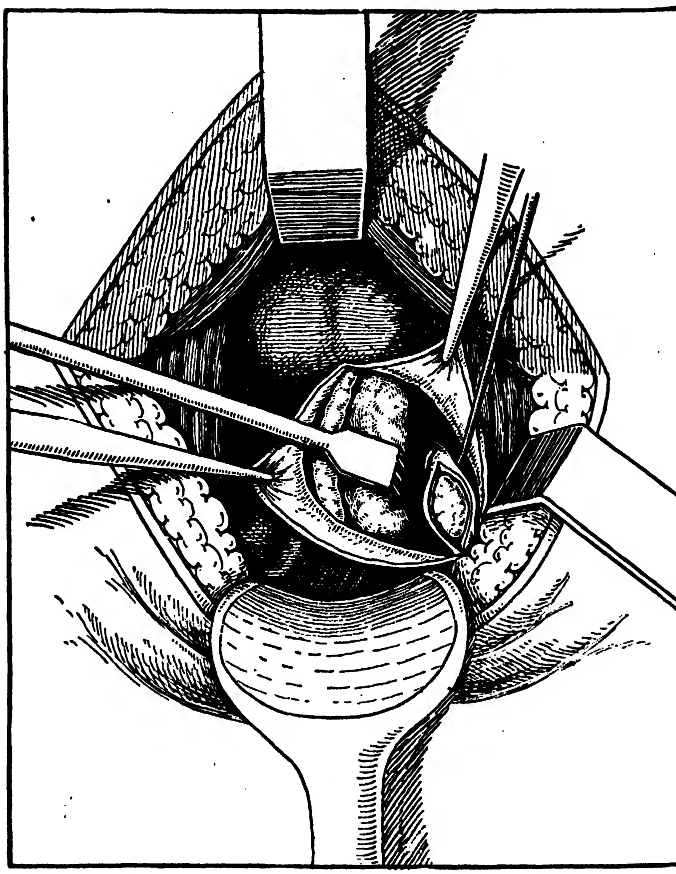


FIG. 414.—PERINEAL URETEROTOMY. Patient in the lithotomy position. The prostate is the upper angle of the wound; the fascia over the seminal vesicle opened; the vesicle and the vas pulled to one side and ureter hooked up and incised over the calculus. (Author's operation.)

Perineal Ureterotomy.—A calculus in the part of the male ureter just above the bladder is considered by some to be the best approached through the Zucker-

kandl perineal incision that is employed for the removal of the prostate or seminal vesicles, as the abdominal operation, especially when made through the oblique muscles, is liable to be followed by hernia. The patient is placed in the lithotomy position and the incision made in front of the anus, up between the prostate and the rectum and just beyond the prostatic base. The ureter is found just beneath or to the inner side of the seminal vesicle, with the vas deferens passing in front of it. It is seized by a blunt hook, the seminal vesicle and the vas are retracted, an incision is made over the calculus and the stone is removed from forceps (Fig. 414).

Drainage is made through the perineum, after which any urine leaking from the wound runs through the sinus remaining in this region, which usually closes slowly. The drain is left in but a few days.

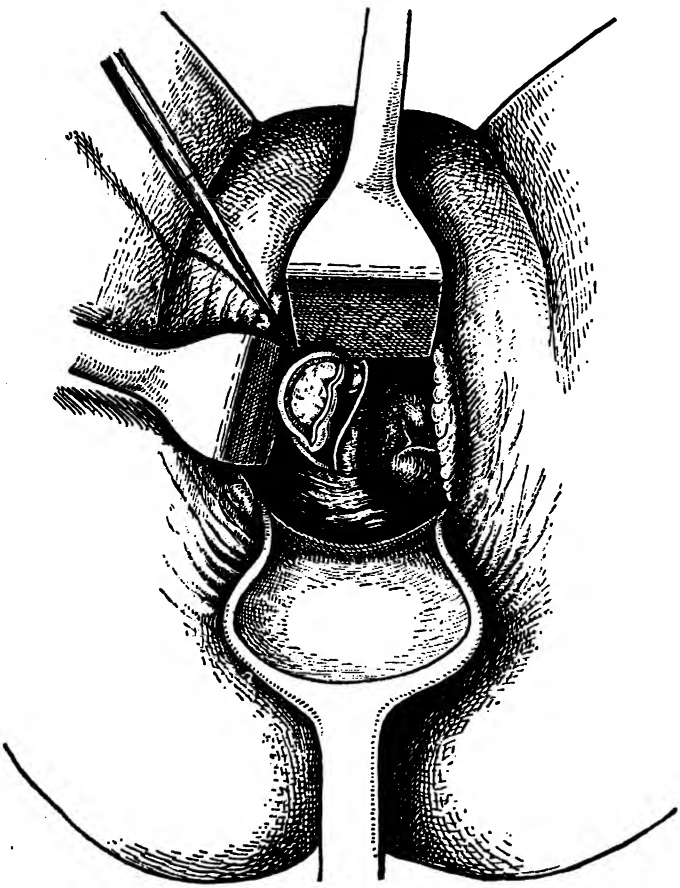


FIG. 415.—PATIENT IN THE GYNECOLOGICAL POSITION. An incision is seen in the vaginal wall by the side of the cervix uteri. The ureter has been hooked up and incised over the calculus.

Vaginal Route.—The lower part of the canal outside of the bladder wall is best approached in women through the vagina. The steps of the operation are as follows: Patient in the gynecological position. The ureter should be catheterized. A transverse incision is made in the vagina from the corresponding side of the cervix uteri, or a vertical one just beside it. After the vaginal wall has been cut through, the catheter and calculus can usually be felt by the finger tip introduced through the incision. If not, the tissues should be pushed down by suprapubic pressure with the other hand. The ureter should now be caught by a blunt hook and pulled down, and a traction suture passed about it by means of a blunt-pointed needle, so as not to wound the uterine artery.

The ureter should then be steadied and a longitudinal incision made in it over the stone (Fig. 415). The calculus should then be removed with forceps, and the catheter pushed through the canal up to the renal pelvis in case this could not be done at the beginning of the operation. The ureteral wall should then be closed by sutures and a drain placed close to the vaginal incision. The postoperative treatment is the same as that already described.

Vesico-uretero-lithotomy.—Vesico-uretero-lithotomy is the operation for removing a calculus from the portion of the ureter passing through the bladder wall. This part of the canal is about three quarters of an inch in length and is best approached by the bladder route.

The steps of the operation are as follows: Trendelenburg position. Suprapubic cystotomy. Pass a fine-grooved probe into the ureter from the bladder; incise the ureter up to the stone (Fig. 416). Insert the blades of a very thin pair of forceps, grasp the calculus and withdraw it. Sometimes it is easier to do this with a very small curette, as in removing urethral calculi. The removal of the stone is sometimes facilitated by counterpressure with the finger in the rectum.

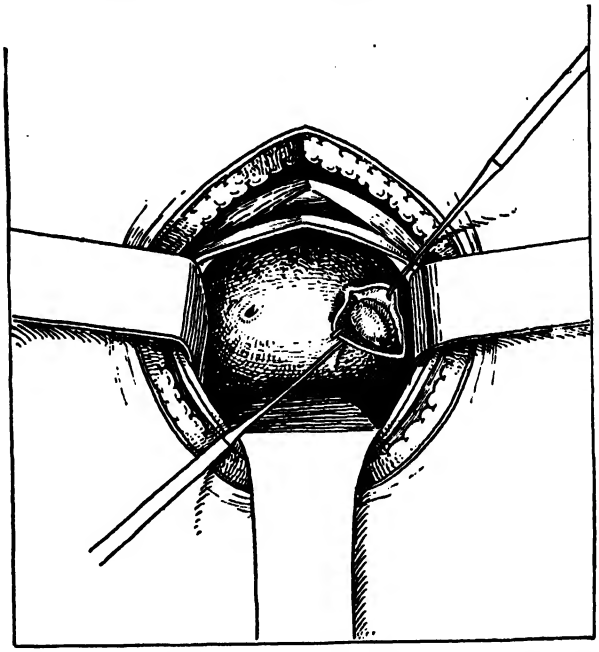


FIG. 416.—PATIENT IN THE TRENDELENBURG POSITION WITH THE BLADDER OPENED SUPRAPUBICALLY. The ureter and the part of the bladder wall through which it passes have been cut through and the stone is clearly seen.

Complications.—When a stricture is situated below a stone in any part of the canal, this should be severed longitudinally after the calculus has been removed, as otherwise the ureteral incision might result in a fistula. This can easily be done in the upper part of the ureter, but sometimes in the lower part of the canal it is necessary to cut the stricture with a urethrotome (internal ureterotomy).

URETEROTOMY FOR STRICTURE

Technique of External Ureterotomy for Stricture.—Stricture of the ureter usually occurs near the upper end of the canal, that is, near the kidney, although it may occur in any part of it. The incision in the abdominal wall

depends on the locality of the narrowing and is therefore made either in the lumbar or the iliac regions.

The ureter is first catheterized with a No. 6 French catheter, which enables the operator to find the stricture, as the catheter stops at this point. It can also be estimated by the distance that it passes up after the distal end has entered the mouth of the ureter. The ureter is found by palpation just below the lower pole of the kidney when the stricture is high up; over the bifurcation of the iliac vessels when it occurs in its middle portion; or between this bifurcation and the bladder in the true pelvis and consequently in the latter two instances the inguinal incision or the incision through the rectus abdominis is made.

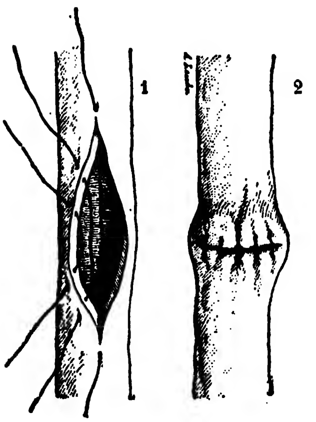


FIG. 417.—URETEROTOMY FOR STRICTURE. (1) Showing the stricture incised longitudinally and the manner of passing the sutures, one from the upper to the lower angle of the wound and two on each side, making five in all. (2) Showing the sutures ligated, making the union transverse and the caliber of the canal consequently wider. (After Albarran.)

After the stricture has been exposed, a ureteral clamp is placed above the narrowing, and the surrounding tissues are walled off with gauze; after which a longitudinal incision is made through the stricture in the wall of the canal. The ureteral catheter is then pushed through the strictured portion and the sutures are passed through the ureteral wall longitudinally.

Five sutures are usually employed, which go through all the layers of the wall, except the mucous membrane. The first suture is inserted just above the upper angle of the incision and comes out just below the lower angle. Two more sutures are then passed through the walls on either side. The sutures are then ligated, which makes the line of union transverse and the strictured portion consequently wider than before (Fig. 417).

A cigarette drain or rubber tube is then inserted down to the point of operation, and the ureter and the abdominal wall should be closed up to this drain. This is withdrawn on the third day. The ureteral catheters, if employed, should be retained for two weeks. The kidney pelvis is washed out once a day with a solution of 1: 2,000 solution of silver nitrate, or 1: 500 solution of protargol. The skin sutures are removed at the end of a week. Some operators do not consider it necessary to retain the ureteral catheter after operating, as the strictured part of the urethra is so much enlarged by the operation.

URETERORRHAPHY

Ureterorrhaphy is an operation for repairing partial wounds of the ureter occurring during operations.

Partial or *incomplete ureteral wounds* are those that do not include the entire circumference of the duct. When the injury has divided the ureter into two pieces, one connected with the bladder and the other with the kidney, it is called a complete wound and the operation consists in suturing together the two ends of the ureter, to which the name uretero-ureteral anastomosis or uretero-ureterostomy has been given.

Wounds of the ureter are for the most part accidental, occurring usually during vaginal and suprapubic hysterectomies for malignant growths, although sometimes the surgeon deliberately cuts through the ureter in the removal of a tumor. It is sometimes cut through higher up in freeing adhesions and in removing the adnexa. Sometimes the ureter is displaced forward by a fibroma in front of the uterus and is therefore subjected to injury. The ureters are occasionally, although much less frequently, injured through other than operative accidents.

In the case of longitudinal wounds of the ureter, their edges tend to remain in contact; whereas in oblique or transverse wounds, in which the ureter is not completely divided, the wound gaps and is oval.

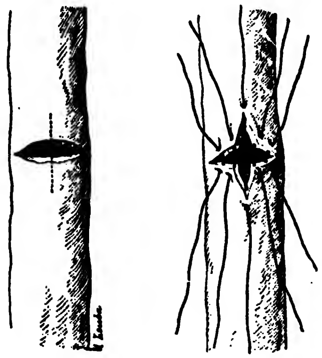
When the ends are completely separated, they can easily be brought together again, except when too much of the ureter has been injured or removed or when the operator is not able to find the injured segments.

Every wound of a ureter, complete or incomplete, not sutured, may form a fistula which later either heals spontaneously or persists; consequently a cicatricial stricture may also result, complicated by renal retention and uretero-renal infection. The fistula may open into the vagina, or through the abdominal wall. The wound in the ureter may be surrounded by a mass of inflammatory tissue. Above the fistula the ureter is dilated. The part of the ureter between the fistula and the bladder is usually thickened but permeable. A cicatricial stricture may also result, complicated by renal retention and uretero-renal infection. The greatest danger in wounding the ureter during a laparotomy is through infection of the peritoneal cavity by septic urine and a consequent septic peritonitis.

Technique of Ureterorrhaphy.—First, free the ureter and compress it to prevent urinary leakage. It can be compressed above the injury with a piece of gauze, tape or ureteral clamp. The ureteral wound having been exposed, it can be united by longitudinal, transverse or oblique interrupted sutures of fine chromic gut, care being taken not to perforate its mucous wall.

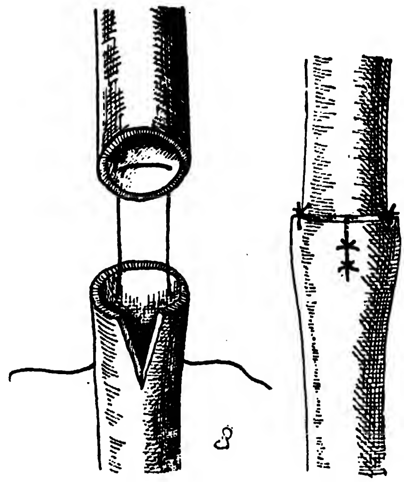
The operation for the union of a longitudinal tear is that of ureterotomy for stricture (Fig. 417). The operation for a transverse wound necessitates the making of two incisions a sixth of an inch long, one upward and one downward from the middle of the transverse wound and then proceeding as follows: The first suture should be from just above the upper angle of the longitudinal cut to just below the lower angle. The second suture should be introduced through

either side of the longitudinal cut just above the angle that it forms with the transverse wound and comes out in the corresponding position below. Another suture should then be placed through the transverse wound on either side near its ends (Fig. 418, *A* and *B*). This also results in a transverse line of sutures making the ureter wider than before at this point.



A B

FIG. 418.—URETERORRHAPHY. (*A*) A transverse tear. A longitudinal incision one sixth of an inch in length extends upward and downward from its middle point. (*B*) Five sutures are then passed: one from the upper to the lower angle; one through either side of the longitudinal cut just above the angle it forms with the transverse wound, and one other on each side of the transverse incision near its end. When ligated, a transverse wound results larger than the remainder of the canal. (After Albarran.)



A B

FIG. 419.—POGGI'S OPERATION. *A*, The manner of placing the sutures prior to invaginating the upper segment into the lower. *B*, The anastomosis completed and the sutures in place.

URETERO-URETEROSTOMY

(*End-to-end Anastomosis*)

The operation of uretero-ureterostomy is performed when the ureter has been completely severed in abdominal operations. The operations are the Poggi, the Van Hook and the Bovée. Of these, the Poggi operation appeals to me the most (Fig. 419).

The Poggi Operation.—The ends are approximated. Both ends are cut transversely in case they are irregular. The distal end is stretched and then a slit is made on its anterior surface one sixth of an inch long, to enlarge it sufficiently to allow the upper end to enter it. A plain catgut suture is passed one eighth of an inch from the cut surface through the posterior wall of the upper segment from within outward, resembling an inverted "U." The ends are then brought down and through the posterior wall of the lower segment, from within outward, at a corresponding distance from the cut surface; then the upper segment is pulled into the lower segment and the ends of the sutures tied behind, after which the sides are sutured together with No. 1 chromic gut. The anterior slit is also sewed together, including the invaginated segment,

with two sutures of the same size. None of these holding sutures go through the mucous membrane, as is the case with the plain gut suture.

Van Hook's Method.—In this procedure, which involves a shortening of the duct, the peripheral end of the ureter is ligated near the line of division and a longitudinal incision is then made below the ligature. The incision should be twice as long as the diameter of the ureter. The central end is slit for five to six millimeters, to keep it gaping, and a "U" suture is applied, passing from within outward. The two ends of this thread enter the peripheral stump of the ureter through the wound, passing through the walls, from within outward, below the lateral slit. The central fragment of the ureter is invaginated into the peripheral fragment by pulling it into the opening and tying the two ends of the suture on the outside wall. The anastomosis is completed by suturing the longitudinal wound of the lower segment on each side of the graft (Fig. 420).

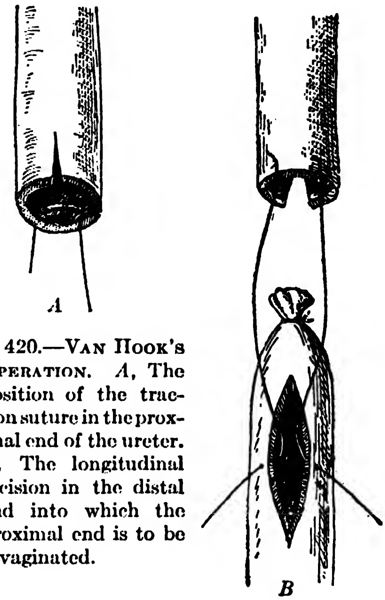


FIG. 420.—VAN HOOK'S OPERATION. *A*, The position of the traction suture in the proximal end of the ureter. *B*, The longitudinal incision in the distal end into which the proximal end is to be invaginated.

Bovée's Method.—This procedure was devised with the object of preventing the occurrence of constriction, which is apt to follow after anastomosis by the end-in-end, the end-in-side and the transverse end-to-end method of ureteral union (Fig. 421). In Bovée's oblique end-to-end junction, the divided ends of the ureter are trimmed obliquely, brought together and united by two rows of interrupted sutures not penetrating the mucosa.

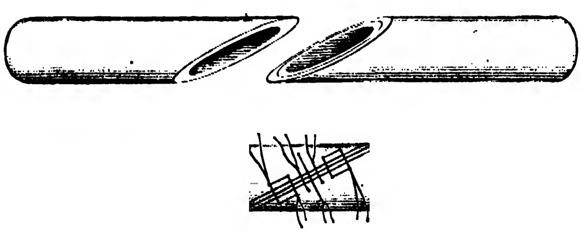


FIG. 421.—BOVÉE'S METHOD OF END-TO-END ANASTOMOSIS BY APPROXIMATING OBLIQUELY CUT ENDS WITHOUT INVAGINATING THEM.

After these operations, the peritoneum is sutured and a drain is inserted through the abdominal wall on a level with the suture, after which the abdominal wound is closed up to the drain.

URETEROSTOMY

Ureterostomy is the name given to the grafting of the proximal end of the ureter into the skin.

The grafting of the proximal segment of a ureter into the skin after an injury is the simplest method of establishing the elimination of urine from the corresponding organ. This operation is a very simple one, but the results have been far from satisfactory and most of the patients have survived the operation but a short time. I consequently cannot recommend the operation and think that a nephrostomy with direct drainage from the renal pelvis into the loin, or even a nephrectomy, promises better results. The patients usually die of pyelo-nephritis or pyonephrosis, due to renal infection after this procedure.

When an injury is due to an accident during a laparotomy, some ligate the distal fragment and bring the proximal fragment into the lower angle of the abdominal incision. This operation is, however, best applied to cases in which the external opening can be made in the lumbar region. The ureter, having been compressed above the seat of injury, is freed from its normal position and the end is brought into the lower segment of the wound, as has already been mentioned. In fixing the ureter, we must allow for a sufficient length of the duct to drain the kidney and take care not to form a loop of sufficient length to have it sag and retain urine.

Two small incisions, a quarter of an inch long, are made opposite one another in the end of the canal to fit the skin opening better. The ureter end is then made fast to the skin by any suture not going through the entire ureteral wall.

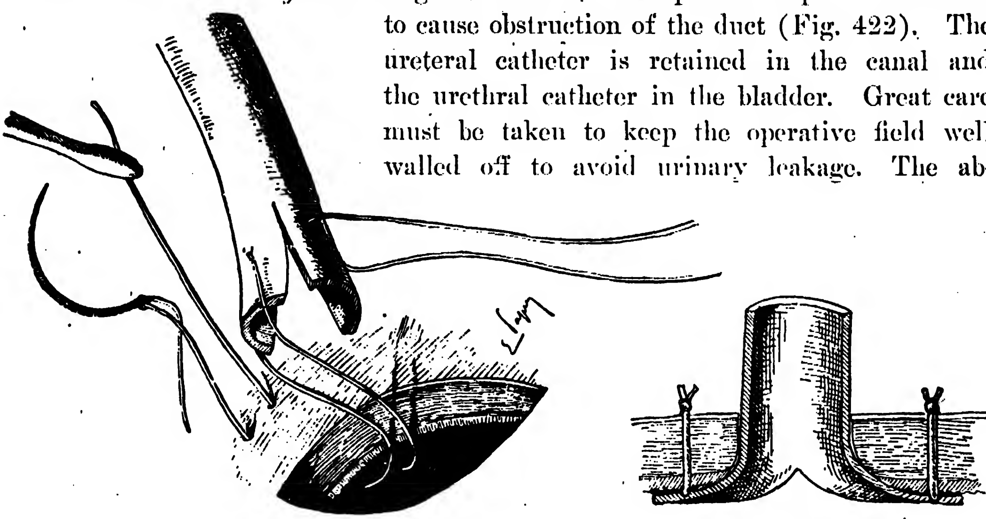
A ureteral catheter should be left in for some days. The lumbar wound is closed as usual. The operation is unsatisfactory and I do not recommend it.

URETERO-CYSTOTOMY

Uretero-cystotomy consists in operating upon the ureter for injuries near the bladder, which usually occur in women during a hysterectomy operation, and making an anastomosis of this canal with the bladder. It is performed by the transperitoneal, extraperitoneal and transvesical routes.

Transperitoneal Method.—A median laparotomy is performed (Fig. 413). The lower segment of the ureter is ligated and the end cauterized. It is sometimes difficult to find the upper segment that we intend implanting in the bladder, as it retracts; in which case the iliac vessels should be cut down upon and the ureter found and freed down as far as its end. Two slits, one sixth of an inch long, are then made on either side in the end of the proximal portion of the canal and an inverted " U " suture is passed through the ureter on either side, the vault of the inverted " U " being on the inside of the ureter. The ends of these sutures are threaded on thin curved needles. A diagonal slit is now made on the posterior lateral wall of the bladder and a ureteral catheter is passed up from below and out of the bladder incision into the ureter. The ends of the

"U" sutures are passed through the bladder wall on the two sides of the incision, from within outward, and the end of the ureter is pulled into the bladder. The ends of the sutures are then pulled taut and tied on the outside of the vesical wall. In this way, the opening of the ureter in the bladder is held well open. The bladder is then closed up to the ureter on either side with fine silk sutures, care being taken not to make pressure upon it sufficient to cause obstruction of the duct (Fig. 422). The ureteral catheter is retained in the canal and the urethral catheter in the bladder. Great care must be taken to keep the operative field well walled off to avoid urinary leakage. The abdominal wall should then be closed. Drainage can be established through the vagina by passing pointed scissors up to the side of the cervix uteri and through the vault of the vagina on that side and inserting a tube, cigarette drain or wick. The flat dorsal or the dorsal reclining position is recommended after operation.



A B

FIG. 422.—TRANSPERITONEAL METHOD IN URETERO-CYSTOTOMY. A, The manner of passing the sutures through the ureter and bladder. B, The manner of tying the sutures on the outside of the bladder wall.

Various other methods of implantation are used by means of buttons and different devices. The simple method of stabbing a hole in the bladder from the outside with a scalpel, pushing the end of the ureter into it with thumb forceps and suturing the outer wall of the ureter to that of the bladder on either side, has been successful in many cases without the use of a ureteral catheter.

Extraperitoneal Uretero-cystotomy.—This route is a difficult one to follow out in women, as the ureter is usually cut during a hysterectomy in the region of its greatest exposure, which is just behind the uterine vessels; after which it retracts. It would therefore be necessary either to close the peritoneum and then separate the tissues extraperitoneally until the ureter is found; or else to make another incision in the side of the abdomen, which would weaken the wall considerably and predispose to hernia. After an operation on the adnexa and especially after a hysterectomy, the transperitoneal route is easier. In men, injuries or any other conditions requiring an extraperitoneal uretero-

cystotomy are very rare. It appears, therefore, that the transperitoneal uretero-cystotomy is the better (Fig. 413).

Uretero-vaginal Anastomosis.—A uretero-vaginal anastomosis is not recommended, as it is usually followed by hydronephrosis. The best result that can be obtained by this operation is a uretero-vaginal fistula, which is not desirable.

Transvesical Uretero-cystotomy.—Transvesical uretero-cystotomy is also not recommended. This operation consists in making a suprapubic cystotomy, inserting a grooved director into the ureter, grasping and pulling the ureter into the bladder and incising and separating its ends, as in the case of the transperitoneal operation. After this, the ends should be sewed to the muscular wall of the bladder from its inside, or else the peritoneum should be opened above the bladder and the suture passed through the bladder wall from the inside and ligated on its outside through the peritoneal incision. In this operation, there is great danger of infection of the peritoneum by the urine and it cannot be recommended.

URETERO-INTESTINAL ANASTOMOSIS

(*Grafting of Ureters to Intestine*)

This operation is performed:

1. For accidental wounds of the ureter, when neither uretero-ureteral anastomosis nor vesical grafting appear feasible.
2. For the cure of ureteral fistula. (Chaput.)
3. After total cystectomy. (Küster.)
4. In exstrophy of the bladder. (Simon.)

Ureteral grafting into the intestine is a serious operation, with a very high immediate and remote mortality, which may be estimated as thirty-five to forty per cent. The high operative mortality is due to local infection about the anastomosis giving rise to abscess, fistula and stricture in cases immediately after the operation or to a renal infection at a later date.

Selection of Intestinal Segment.—The rectum, sigmoid flexure, cecum and ascending and descending colon, have been principally used for this purpose.

The operation is usually performed by the intraperitoneal route, although occasionally the ureter has been grafted to the colon or rectum by the extraperitoneal route.

Uretero-colostomy.—This operation can be performed by either the extra- or intraperitoneal route. The steps are:

Expose the ureter; free the ureter; suture the ureter to the colon.

The first two steps have been described under the extra- and intraperitoneal incisions in ureteral surgery (Figs. 409 and 413).

Operative Technique.—The ureter is freed and brought in contact with the portion of the colon chosen for the seat of the anastomosis. The intestinal

wall is freshened and uncovered at this point. The parietal peritoneum is incised from the region of the ureter to that of the colon and the two sides dissected back. The ureter is placed in this space and brought in contact with the intestine.

At one and one half centimeters from its cut end, a suture is passed through the outer layer of the ureteral wall, fixing it to the lateral wall of the colon, after which the free edges of the peritoneum are brought over the ureter and the wall of the colon is also sewed over it in such a way as to bury it.

On the anterior surface of the colon a quadrilateral flap is made on either side of and across the longitudinal band of the gut, two centimeters long and one centimeter wide, extending through the serous and muscular coat.

The incision of the flap is made on either side and below but not above, which part is left intact.

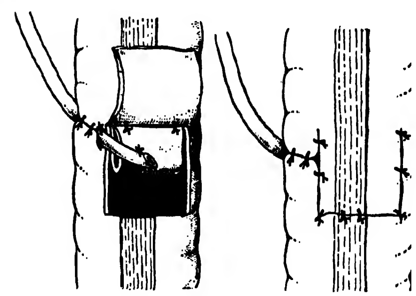


FIG. 423.—URETERO-COLOSTOMY. *A*, The line of incision of the flap through the serous and muscular coats of the colon. *B*, The colon flap lifted up and a muscus flap of the same size folded on itself and fastened above. The ureter is seen buried in the side of the intestinal wall and fastened to the muscus flap. *C*, The sero-muscular flap brought down in place and sutured to the line of incision. (Pierre Duval.)

The flap is then reflected upward. The mucous coat of the gut is then cut through in the same lines of incision and folded upon itself and attached by sutures at its upper edge in such a way as to form a mucous valve (Fig. 423, *A*).

The end of the ureter is placed on the front of the mucous surface of the valve and fastened there by suture (Fig. 423, *B*).

The reflected sero-muscular flap is then brought down over the mucous valve and the end of the ureter, and is sewed to the edges of the wound in the intestine below and on its sides, thus burying the ureter (Fig. 423, *C*).

It will be seen that the ureter then has an oblique tract and a valve at its new orifice.

URETERECTOMY

Excision of the ureter is performed in tuberculosis of the kidney and ureter and in suppurative cases in which the ureter is involved on account of fistulas, strictures and ureteral retention of urine or pus. Ureterectomy may be primary or secondary. In the first instance, the ureter is removed with the kidney and in the second instance after the removal of the organ. It may be partial or total, the former when only a segment is removed prior to some anastomosis.

Technique of Ureterectomy.—The ureter should first be catheterized from below up, or from above down, and any fistulas present should be curetted and

washed out with peroxid. A curved incision is recommended from the kidney angle down along the erector spinæ muscle, past the anterior superior spine of the ilium to the external border of the rectus abdominis muscle, nearly to its insertion (Fig. 424). The different muscular planes are then cut through down to the subperitoneal fat. The ureter is then felt for in the lumbar region, where it is more exposed; but in case it is not found there, it should be sought in the iliac fossa. In looking for the ureter, the fingers of the operator's hand should

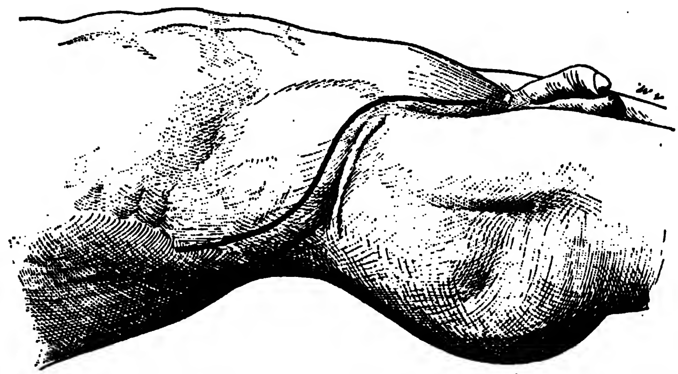


FIG. 424.—ILEO-LUMBAR INCISION FOR A COMPLETE NEPHRO-URETERECTOMY. (From Pierre Duval.)

gently work their way under the peritoneum with their backs pointing to the abdominal wall while making traction on the peritoneum with the other hand. The ureter is usually quite easily discovered on account of the hard feel transmitted to it by the contained catheter. Sometimes, however, the ureteral catheter is stopped in its course by tuberculous thickenings of the ureter, by strictures and by fistulous tracts causing a narrowing of the canal below them. In that case, the ureter should be cut down upon at the highest point to which the catheter has passed and the work can be begun at this point. In any case, after the ureter has been found, a traction suture should be passed about it and it should be separated down to the point at which it joins the bladder. A ligature is then placed around the ureter, three quarters of an inch from the vesical wall, and the ureter is seized and lifted up, a gauze pad is placed beneath the ureter to protect the surrounding tissues and the duct is cut through with scissors; after this the lumen of the stump is cauterized by carbolic acid or a Paquelin cautery. The upper segment of the ureter should then be dissected out. In case there are adhesions along the tract, it may be necessary to dissect the ureter out with scissors; whereas, in the case of a fistula, it may be necessary to approach it from above as well as from below. The fistulous tract leading from the ureter must be curetted afterwards to remove all the granulations, in order that it may heal. The entire wound should be closed or a sufficient space can be left above or below to allow the passing of a gauze wick for drainage, if there is an area of periureteral suppuration present.

NEPHRO-URETERECTOMY

In case the kidney and the ureter are removed at the same time, the kidney is first freed and is held as a tractor while the ureter is stripped down to the bladder. In this case, the patient lies, from the beginning of the operation, on the healthy side until after the kidney has been liberated, when he should be turned on his back and the operation continued either flat or partially Tren-

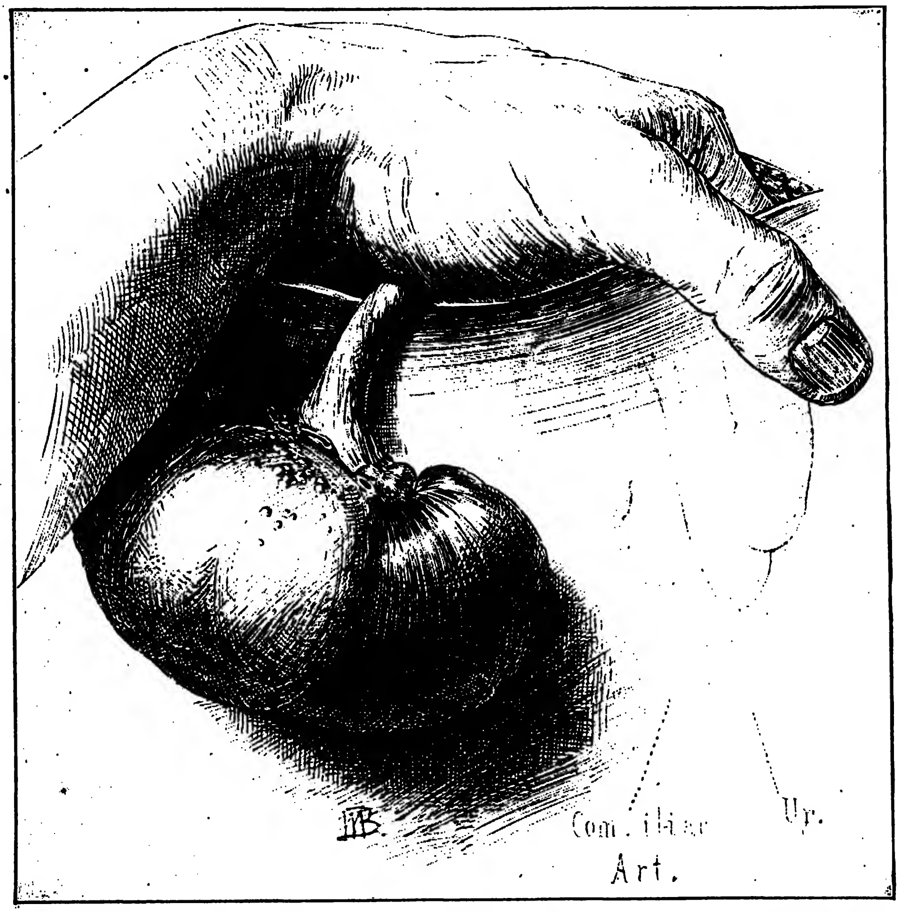


Fig. 425.—Nephro-ureterectomy. Transverse incision in the median line. The kidney removed and hanging. The fingers of one hand are in the incision and free the ureter down to the posterior surface of the broad ligament, where it is ligated and cut away. (From Kelly's "Operative Gynecology.")

delenburg and then perhaps more fully Trendelenburg, as the bladder is approached. A space for drainage should be left above and below, and it should be closed in the middle.

This operation is sometimes done from below upward when there is a large stone, stricture or impassable tuberculous thickening in the lower ureter near

the bladder. The only time I have performed this operation was in the case of a ureteral stricture low down in the ureter with a nonfunctionating kidney above it.

In case the kidney has already been removed and there are no fistulas in

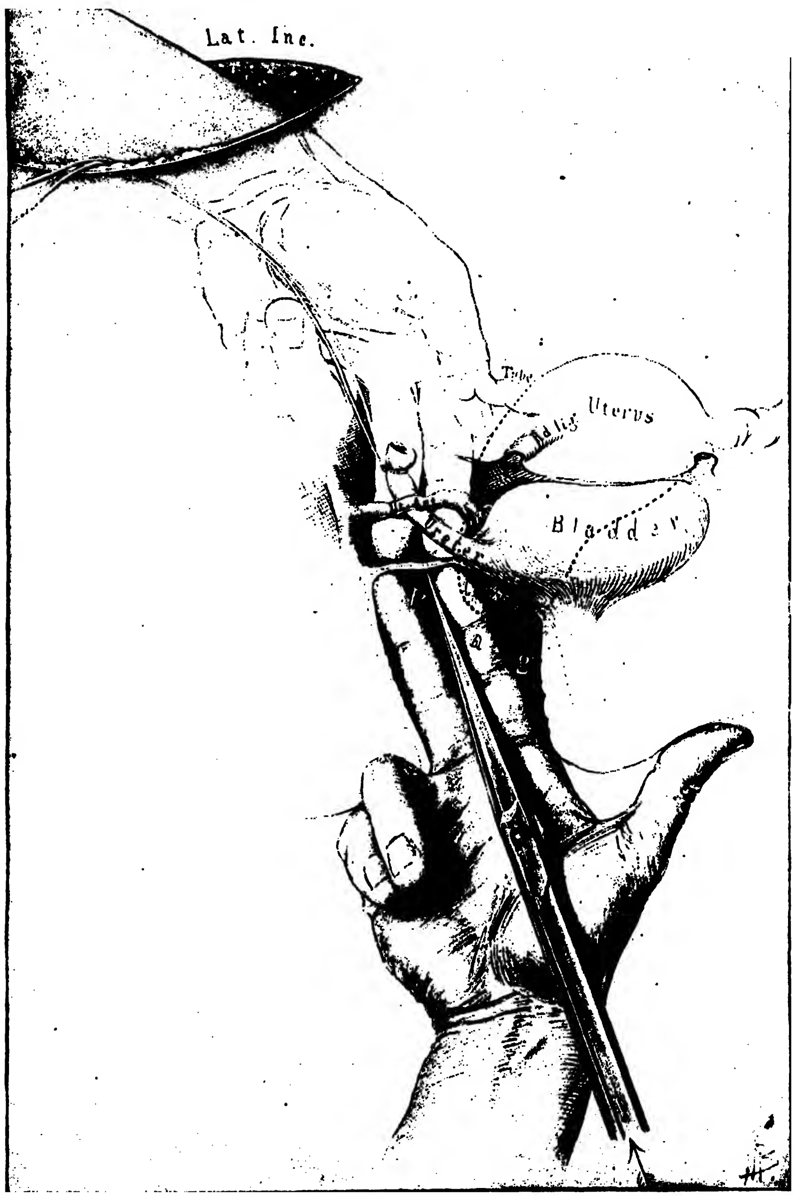


Fig. 426.—Nephro-ureterectomy. Shows the operator's two fingers down to the vaginal wall on one side of the cervix uteri and the fingers of an assistant pressing against them through the vagina. The sharp-pointed blades of a pair of scissors are then thrust up through the vaginal wall between the fingers. The stump of the ureter is then pushed down through the incision and again ligated farther down and cut away. (From Kelly's "Operative Gynecology.")

the loin and the pathological conditions are in the iliac portion of the ureter, the incision through the abdomen anteriorly may suffice for removing the remaining ureter. In other cases, there can be two incisions, one in the loin and one in the groin, with a bridge of tissue between the two; in which case, the kidney has to be removed through a vertical lumbar incision and the entire ureter through the groin. In women, the Howard Kelly method of removing the kidney through a transverse incision and the ureter through the vagina is both practicable and instructive (Figs. 425, 426). The kidney is freed, its vascular pedicle ligated and it is delivered through the transverse incision.

(2)

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